

Sensor Configuration Tool for End-users: Low-fidelity Prototype Evaluation #1

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We designed and evaluated a tool for end-users to assign high-level meaning to sensors they install in an environment. This tool is being built within the context of the Home Energy Tutor project, an end-user-installed system for monitoring, understanding and reducing home energy usage. However, we intend the tool to be useful for other sensor configuration tasks.

Task description

Users of this tool will be able to computationally label sensors as they physically install them in an environment. Specifically, for the Home Energy Tutor, users will create a semantic mapping in the system between a specific sensor and a domestic appliance or domestic location. Users will also receive feedback about whether they have placed the sensors correctly, and will be able to review and correct the mappings they have already created. Optionally, advanced or curious users may be able to learn more about the function of the sensors they are installing.

For the Home Energy Tutor, the use of this tool will be limited to a single, two-hour session, though in other applications the system may be used to re-install or move sensors that are already active in the environment. However, for the initial design we focused more on the former scenario than the latter.

Our system exchanges flexibility and capability for efficiency and approachability. Though a printed manual will accompany the tool, no training will be provided. Since the tool is used very briefly, the steep learning curve generally associated with a multi-function system is unacceptable, and because this is envisioned as a borrowed/leased system, extra functionality does not play into a consumer's cost-benefit calculation. Even if the tool were used after an initial configuration to re-install or move sensors, we expect these events to occur infrequently, and therefore can't expect repetition to factor into the learning curve. Similarly, flexibility is less important than correctness at this layer of the application; more flexible functionality can be added in software if the underlying sensor semantics are correct.

System description

We envision the Home Energy Tutor being shipped to a homeowner from his or her local utility company on a loan/deposit basis for approximately one month. The system would arrive in a box at the home, and include seven main objects:

- The *instruction manual* is a booklet that provides the user with a general introduction to the system and out-of-band information about troubleshooting

- problems with the handheld scanner or sensors. We do not assume that users will read the manual. **[The instruction manual was not provided for this study.]**
- The *quick setup instructions* are printed on a single sheet and provide a brief summary of the high-level instructions for users who prefer not to read the instruction manual. All information in the quick setup instructions is also covered in the instruction manual.
 - The *item catalog* contains a set of pictographic representations and text descriptions of appliances and locations in a typical home. Each item in the catalog is barcoded; the user scans a barcode to label an item on the handheld. The user may scan an item in the catalog or may write a personal note about the meaning of a generic location or appliance (e.g., Bedroom 1 = Joe's Bedroom) next to an item.
 - The *sensors* transmit information to the system base station about the object to which they are affixed. Importantly, sensors are affixed after the fact in legacy environments – they cannot be invasive (inside an appliance) or require heavy lifting to deploy. There are three types of sensors in our system: vibration, current, and motion. Each sensor has a barcode which uniquely identifies it to the system. For the system to make sense of the data stream transmitted by the sensors, the user must label each sensor with the item to which it is attached. The sensor also provides feedback through the handheld if it is configured correctly. The user labels a sensor by scanning the barcode of the catalog item that best represents the item to which the sensor is attached and then scanning the barcode on the sensor.
 - The *handheld scanner* guides the user through the sensor configuration process with onscreen prompts, reads the barcodes in the catalog and on the sensors, and transmits the catalog labels for each sensor back to the base station. The user may refer to the handheld display for direction, may scan barcodes with the handheld, may confirm labels as they create them, and may review labels they have already created.
 - The *display* provides low-bandwidth, real-time, ambient feedback about household energy use. Several designs are being explored for this part of the system. **[The display was not provided for this study.]**
 - The *base station* receives the data streams from the activated sensors and uses the labels the user creates to provide suggestions about energy usage. The user may not directly interact with the base station, but it is an important conceptual part of the system because it is where the “information goes.” The base station is also a resource for particularly curious users to explore the system in depth. **[The base station was not provided for this study.]**

In the context of the Home Energy Tutor, these objects are used in an indoor domestic environment. Weather is not a constraint for their use, but available light (too much to scan a barcode or too little to read the catalog) is a consideration.

Target user characteristics

This tool will initially be used by participants in the Home Energy Tutor project. Specifically, the users of the configuration tool are expected to be adult, reasonably

intelligent homeowners. However, technologically naïve homeowners may have tech-savvy children that they allow to do the configuration; we anticipate constraining the handheld interface tightly enough to prevent misconfiguration through exploration.

Demographically, we expect our users to be able-bodied homeowners (who are generally at least 25, but not older than 70), male or female, and from mainstream American society. We also expect our users will have at least a high school diploma, and may be professional or blue collar. We anticipate that a large number of our users will be full-time homemakers. If the system were to be deployed in an immigrant or non-Western home, significant exploration would be required to consider privacy concepts and other local social norms.

We expect that user's previous experience and skill with configuration of home electronics devices (particularly multi-mode, multi-menu devices like VCRs and TVs) will be relevant to their experience with our system. Because the system mainly concerns a user's own home, we expect that they will have the requisite domain knowledge: familiarity with home appliances and some association between appliance operation and energy usage.

Study goals:

The five main goals for this study were:

- To explore user understanding of the *labeling* concept
- To evaluate the design's success in enabling users to install sensors
- To evaluate use of barcode scanning as input method
- To understand awareness of home energy use
- To understand the attractiveness of various types of home energy use information

Study introduction

Each trial we conducted consisted of four main parts, always in the same order. First, we used a questionnaire (Appendix A) to investigate each participant's tech-savviness, familiarity with the configuration of electronic devices and services, and interests in and awareness of home energy use. Second, we used a "Wizard of Oz"-style (Figure 1) task-directed exercise to evaluate the system's usability in guiding the user through installation of sensors. Third, we used another task-directed exercise to evaluate the usability of the planned deployment handheld and barcode scanner – an HP iPaq 5450 and Socket barcode scanner (Figure 6). Finally, we used a post-task interview to investigate the user's understanding of the system and its installation, home energy use concerns and interests, and social issues surrounding putative use in their own homes.



Figure 1: The handheld Wizard-of-Oz technique. The participant (at left) interacts with the handheld scanner, while the "computer" prepares to change screens in response to his input.

We performed pilot trials with two participants, one lab employee and one relative of a lab employee. For the actual study, eight homeowners participated in separate trials at our laboratory near the University of Washington in Seattle, in return for a \$25 US cash incentive. Seven participants were female, one was male, and their reported age ranges were from 27-30 to 56-60. Only one participant (A1) was involved in a chiefly technical occupation. Seven of the eight participants lived in Seattle or the metropolitan area, and the remaining participant lived in Victoria, BC, Canada, within 200 miles of Seattle.

We targeted our recruiting efforts to homeowners in the Seattle area who were willing to come to our lab during business hours or immediately before or after business hours. We recruited by several methods. Tear-off flyers (Appendix B) were placed in several locations near the lab considered to be frequented by homeowners: grocery stores, gyms, community centers and merchants. The authors sent email to distribution lists within the University of Washington, and also directly to other individuals or friends of individuals (not immediate family of the investigators or other lab employees) who met our screening criteria.

The study was conducted from June 26, 2003, to July 3, 2003. The sessions were consistently 50 minutes on average; one notably long session (A8) ran to 75 minutes. Notes were the only form of data collection for the study, as experiences in the pilot indicated greater participant discomfort with video recording, and we were eager to avoid the extra overhead of transcribing or coding video material.

For each trial, two investigators were required: the moderator, who was chiefly responsible for interacting with the participants and taking notes, and the "computer,"

who simulated the behavior of the handheld scanner mockup. Chris Beckmann served as moderator for all sessions; Sunny Consolvo served as computer for the participants A1 through A5, and Peter Roessler served as computer for participants A6 through A8. Because parts of the study took place in public areas of the lab, people other than the investigators were present during the sessions, but did not interact directly with the participants.

Conducting the study

Each trial began by welcoming the participant and allowing them a moment to use the restroom or get a beverage. Participants were then led to a private, windowed conference room in the back of the lab. Before the study continued, each participant was asked to examine and sign a release form indicating their understanding of the general terms of the study and willingness to participate (Appendix C). As a show of good faith and to reduce the participant's anxiety, we offered the \$25 US cash incentive immediately after completion of the release form. Following this, the participant was asked to fill out the seven-page questionnaire, during which time the investigators left the room.

After completion of the questionnaire, the participant was given a more detailed introduction to the system, the future scenario in which it would be used, and the experimental protocol. The participant was told that the system was intended for monitoring home energy usage and household activity, and providing feedback as information about actual energy use or recommendations for reducing their energy use. The participant was also told that the system would be loaned to them for a month by their local energy utility, not purchased, and that it would be shipped to their home in a box, requiring their effort to set it up. The unfinished nature of the prototype was made clear at this point, and it was explained that the investigator 'playing computer' would be simulating the behavior of some of the electronic devices in the system. Participants were also encouraged to think aloud as they used the system, and to ask questions, though the investigators might be unable to answer the questions until the end of the session. After this introduction, the user was given the carton containing the system, and asked to explore it and to inform the investigators when they were ready to begin. The carton contained the following items (Figure 2):

- Particleboard mockup of handheld scanner (Figure 3)
- Two red magnetically-backed "Type V sensors" (Figure 4)
- Two yellow grounded-plug "Type C sensors" (Figure 4)
- Two blue adhesive-backed "Type M sensors" (Figure 4)
- Item catalog (Appendix D and Figure 3)
- Quick-start guide (Appendix E)
- List of carton contents (Appendix F)

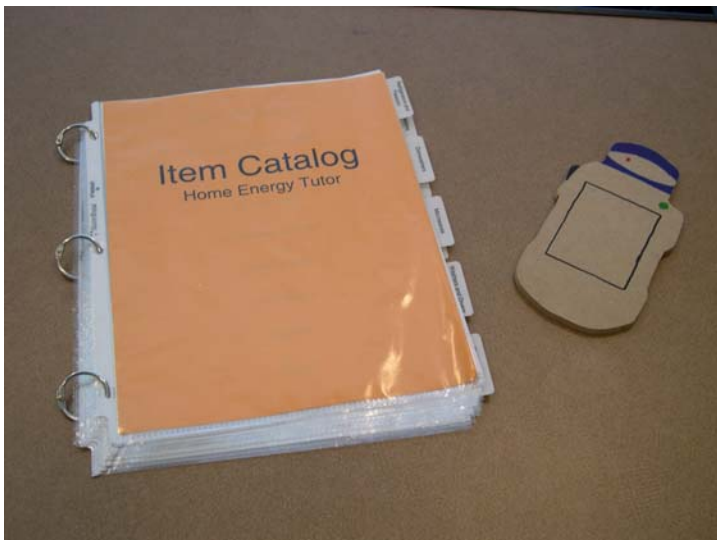
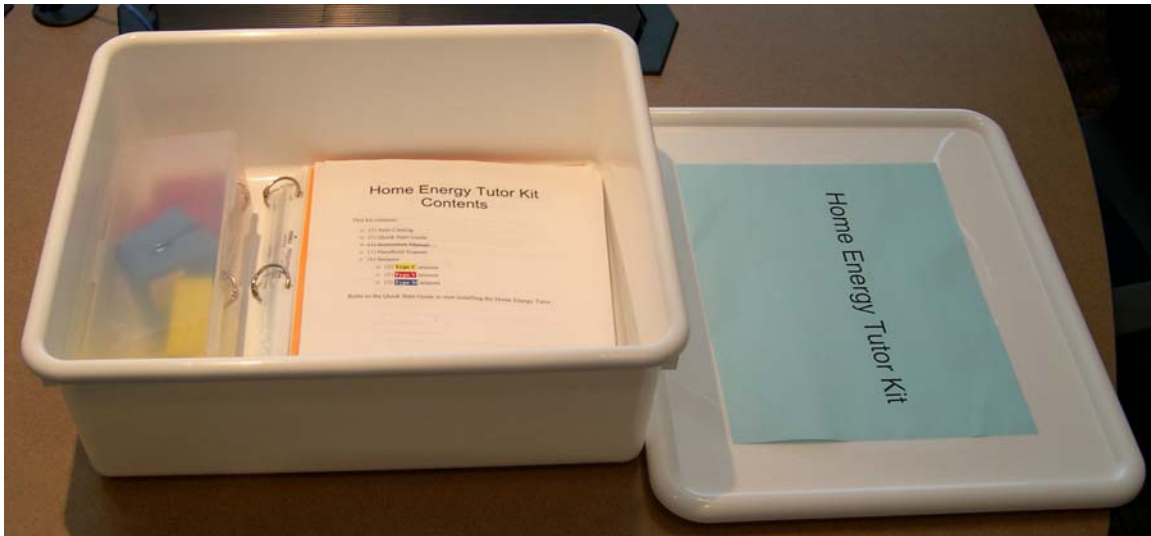




Figure 4: The sensor mockups. From left, "type M," "type V," and "type C" sensors.

For each task, if the participant did not succeed within a reasonable amount of time, became overtly frustrated, or explicitly gave up, the investigators moved on to the next task directive.

Task 1: "Label the refrigerator"

When the participant was ready to begin, they were given an index card instructing them to "Label the refrigerator." The participant was guided from the conference room to the lab kitchenette where the appliances were located. When the participant activated the handheld device, the investigator playing computer began swapping screens on the handheld scanner in response to his or her input (Figure 5). The correct completion of this task required scanning "top-freezer refrigerator" from the item catalog, scanning one red "Type V" sensor, and placing the scanned sensor on the lower half of the refrigerator.

Task 2: "Label the toaster oven"

For the second task, the participant was given an index card instructing them to "Label the toaster oven." The correct completion of this task required scanning "toaster oven" from the item catalog, scanning one yellow "Type C" sensor, and plugging the sensor into the wall outlet and the toaster oven into the sensor. The participant was advised that they were not actually required to plug the devices in if it made them uncomfortable.



Figure 5: The "computer" investigator, right, manipulates the interface on the handheld scanner held by the participant, left.

Task 3: "Label the living room"

For the third task, the participant was given an index card instructing them to "Label the living room." They were then guided to the lab's quiet room, which stood-in for a real living room for the study. The correct completion of this task required scanning "living room" from the item catalog, scanning one blue "Type M" sensor, and attaching the sensor to the wall facing the doorway with the included adhesive strips.

Task 4: Barcode scanning

The fourth task was conducted in the original private conference room. The participant was given a more-specific set of scanning instructions (Appendix G) and asked to choose two appliances and two rooms from the item catalog, indicate verbally which item they were trying to scan, then to scan it. Unlike the previous three tasks, the fourth task used real hardware – a PDA and barcode scanner attachment – but lacked an actual design implementation – there was no change on the device display to correspond with the scanning action. The correct completion of this task required pressing the button on the upper-left-side of the handheld, aiming the scanner emitter at the correct barcode, and producing the tone feedback from the device (Figure 6).



Figure 6: The scanning task with the candidate hardware. Note the emission line in the upper left of the photo.

Post-task interview

After the completion of the barcode scanning task, the participant was interviewed about their experience during the study. Questions focused on these areas:

- **[Interface and system design]** How could the interface design have been better? Were there wording or other (conceptual) issues that were unclear?
- **[Scanning hardware]** How was the experience of scanning? Would you move the scanning function to another button on the handheld?
- **[Conceptual model of configuration]** What was the purpose of scanning a sensor, and then scanning an item from the catalog? What did that tell the system?
- **[Willingness and interest]** Would you install it in your own home?
- **[Home energy use information presentation]** What sort of information would you be interested in? We're considering these alternatives: (a) Direct display of energy use by appliance; (b) suggestions from the system about behavior changes you could make to save energy at home; (c) recommendations from the system about whether or not it would make sense to replace an appliance; (d) competitive information, comparing your household's energy use to other households like it.

Study findings

The study resulted in five main categories of findings. First, we found technical issues with the proposed platform for the handheld scanner. Second, we found issues related to the user interface graphic design, flow, and wording. Third, we found issues stemming from the paper documentation provided with the system. Fourth, we found issues related to the physical design of the sensors. Last, we found a set of conceptual issues related to participants' overall understanding of the system. We will now examine each category of findings.



Figure 7: The candidate hardware platform. The scan actuation button and scanner emitter are labeled.

Technical issues with handheld scanner

While barcode scanning seemed overall to be a comfortable paradigm for the study participants, there were several technical interaction issues with the specific platform (Figure 7) we investigated in Task 4.

- In particular, many participants either explicitly reported that the button which activated the scanner's laser emitter was difficult to find or difficult to press, or simply demonstrated difficulty in activating the scanner.
- Once participants were able to activate the scanner, several were unsure of where to point it in order to read a barcode.
- One particularly confusing interaction involved a participant correctly activating the scanner, but not finding where the scanner emitted and read from until after the scanner had deactivated itself (about three seconds).
- A majority of users also demonstrated or reported awkwardness in aiming the scanner at a barcode on a page resting on a table in front of them; this may have been directly related to their sitting posture for this part of the task.
- Two more-isolated issues related to scanning included using a swiping motion over the barcode rather than a point-and-shoot gesture (perhaps related to the motion often used in grocery store self-checkouts), and an uncertainty about the orientation of the scanner emission line relative to the barcodes.

User interface

In general, the user interface on the handheld scanner succeeded strongly in guiding participants through the sensor configuration tasks (Tasks 1-3). However, there were four clear areas for improvement in the user interface.

- First, the labeling task loop (Appendices H and I) inappropriately re-introduced participants (screen L1) to the labeling task for every item labeled. This led to confusion on the part of participants about whether or not they were operating the system correctly.

- Second, the varying availability of the ‘back’ and ‘help’ options seemed inconsistent to participants, thought it was designed to be semantically appropriate to the stage of the labeling task.
- Third, several users requested additional context-sensitive help; it seems likely that this would be even more useful if the system were used in an actual deployment setting, which will lack the implicit assurance of the study investigators.
- Fourth, it became clear that users were seriously confused by the directives for the room labeling task – several did not use the adhesive strips to place the sensor on the wall, and one even placed it on the floor in the flow of foot traffic.

Paper documentation

Participants seemed to appreciate paper documentation apart from the handheld interface; this exploits the very common paradigm of a printed instruction manual for home electronics. That said, there are five key improvements to consider for the current design of printed documentation.

- First is the matter of form factor – paper is only as useful as a person’s ability to easily keep it organized and find the information it contains. Several participants shuffled through the set of pages more than once, uncertain where to begin, and one explicitly suggested that all pages come stapled together.
- Second, a few participants became confused during the study tasks between the flow-of-control on the handheld scanner and that on the paper documentation; it was not clear that the directions were purely complementary.
- Third, some following directions on the quick start guide reported that the use of both bullets and numbers was confusing (Appendix E).
- Fourth, some found the names for the appliances overly wordy and awkward (“top-freezer refrigerator,” “type M sensor”).
- Finally, it became very clear that the illustrations for using the tools, particularly scanning, were inadequate; it is likely that a simple illustration of the handheld scanner in use could have eliminated several of the common barcode scanning hurdles.

Sensor design

While the sensor mockups were easily handled by all participants, there are three design improvements to consider for practical and conceptual reasons.

- First, a few participants indicated they would be unwilling to mount any item to their walls with adhesive strips due to fear of damage, whether or not it was claimed to be removable. This is a major concern for mounting motion (“type M”) sensors.
- Second, participants voiced concerns about magnetically-mounted sensors (“type V”) being batted down by pets or children, especially when mounted low, as in Task 1.
- Finally, the “type M” sensor mockup was not designed to be clear about where the sensing took place – one participant, in fact, placed it pointing backwards.

Conceptual issues

Although all participants did understand the chief purpose of the configuration task – indicating to the system what a particular sensor was attached to or where it was located – many had issues with smaller-but-critical conceptual elements of the system.

- First of these was understanding the difference between labeling an appliance, like a refrigerator or toaster oven, and labeling a space, like the mock “living room.” The one-to-one correspondence between sensor and device was clear for the appliances, as is the notion that the sensor is somehow responsible for monitoring energy usage of the device. Many participants were unclear about the purpose of labeling a living room within the scope of the Home Energy Tutor application.
- The second conceptual issue is highly-related – participants did not understand what the sensors were sensing. Several participants commented that they could not make informed decisions about sensor placement because they did not understand how the sensors worked. This was not an issue for the current (“Type C”) sensors.
- Finally, a few participants were concerned with the privacy and information model of the system, as it would affect what sensors they were willing to install and where. For one participant, information reported back to a central location or authority was unacceptable, but information maintained locally and reported in a summary form or compared to national averages was acceptable.

While the study findings show several areas for improvement, it is important to highlight the system’s successes, as well. Most concretely, the majority of participants were able to complete all of the sensor configuration tasks without input or guidance from the investigators. Just as crucial is the participants’ unanimous grasp of the system conceptual model – linking a particular item to a particular sensor – after performing the configuration tasks. Finally, the barcode interaction technique, while still in need of technical polish, was immediately familiar to every participant and reasonably usable.

Home energy interests

Participants expressed interests in several different appliances or potential sources of energy usage in their homes, especially those that seemed to be “missing.”

- First, participants were interested in the energy (electricity) usage of devices that would be difficult to sense non-invasively – overhead lights, a built-in electric range/oven combination, etc. It is not clear how this situation would be improved without more sophisticated sensing.
- Second, participants were interested in determining the electricity usage of appliances or devices in their homes that sparked their curiosity – examples of this include a personal computer, a treadmill, and a TiVo (digital video recorder). This can easily be addressed by providing additional sensors for users to place as they wish, and blank barcodes to create user-assignable labels.
- Third, participants were interested in measuring how recent changes to their home affected overall energy consumption – one participant wanted to know how much energy a new built-in ventilation heated-air return system used. While that

particular case is difficult, it is instructive to note that participants were interested in measuring change.

- Fourth, participants were interested in learning more about the nature of the energy feeding their homes – where it came from, and the reasoning behind the energy pricing model. Both of these energy requests may be difficult to provide or vary by locality, but are certainly articulable by a system of this type.
- Finally, participants were interested in measuring energy usage that was *not* electric – gas water heaters, furnaces, and dryers, as well as water use. While the Home Energy Tutor project has been scoped to focus on electric usage, it is notable that participants confounded energy and water usage into the general idea of conservation.

Information presentation preferences

Participants had a range of strong opinions about how energy use information be presented to them. Initially, we presented participants with three information presentation options – behavior change recommendations, “raw” data about energy usage by appliance, and appliance replacement suggestions. We also asked about whether they would find competitive information useful – comparing their households to other similar households. Of those participants with opinions about information presentation, most were strongly against the concept of behavior change recommendations, indicating they would find it annoying and turn it off, or would be interested in suggestions but judged themselves unlikely to follow them. Participants were most interested in “raw” data about energy usage – how much the fridge uses compared to the TV, the percentage breakdown for the monthly bill, etc. Although inefficient appliances are the worst energy use offenders, participants were neutral about the idea of replacement recommendations, chiefly because of the expenditure of replacing an appliance. Those who were interested were also interested in a cost-benefit analysis, indicating how long it would take to pay off the appliance replacement. One participant was also particularly interested in the complexity and contextualization of recommendations – what the cost externalities were for replacing an appliance (new utility lines, installation, etc).

Conclusion

In conclusion, we found strong support for the usability of the sensor labeling concept. While some participants had difficulty with the mechanics of barcodes and barcode scanning, all were comfortable with the concept of using barcode technology. We confirmed the importance of written documentation and graphics, and believe that further improvements in the written documentation and tool design will improve the usability of the barcode system. Directly relevant to the Home Energy Tutor project, we discovered additional types of home energy information homeowners are interested in, and received feedback and suggestions about the method by which information is conveyed.

Appendix A:

Pre-exercise Questionnaire

IMPORTANT: your answers **will not be used** by us or others for marketing or sales purposes. This is **only for research**—to help us build more user friendly technology.

1. Your **gender**: ☐ Male ☐ Female

2. Your **age**:

- | | | |
|--|--------------------------------|--------------------------------------|
| <input type="checkbox"/> younger than 18 | <input type="checkbox"/> 31-35 | <input type="checkbox"/> 51-55 |
| <input type="checkbox"/> 18-21 | <input type="checkbox"/> 36-40 | <input type="checkbox"/> 56-60 |
| <input type="checkbox"/> 22-26 | <input type="checkbox"/> 41-45 | <input type="checkbox"/> 61-65 |
| <input type="checkbox"/> 27-30 | <input type="checkbox"/> 46-50 | <input type="checkbox"/> 66 or older |

3. Your **occupation**: _____

4. Which best describes your **current employment status**? (check one)

- | | |
|---|-------------------------------------|
| <input type="checkbox"/> Full-time employed | <input type="checkbox"/> Retired |
| <input type="checkbox"/> Part-time employed | <input type="checkbox"/> Student |
| <input type="checkbox"/> Homemaker | <input type="checkbox"/> Unemployed |

5. Which best describes your **current marital status**? (check one)

- | | |
|---|-----------------------------------|
| <input type="checkbox"/> Single | <input type="checkbox"/> Divorced |
| <input type="checkbox"/> Single w/Partner | <input type="checkbox"/> Widowed |
| <input type="checkbox"/> Married | |

6. How **many children** do you have? _____

If you have children, what are **their ages**? _____

How many currently **live with you**? _____

7. Where do **you live**? (City, State) _____

8. Are you a **home owner**? ☐ no ☐ yes

If yes, for how many years have you **been a home owner**?

- | | |
|--------------------------------------|---|
| <input type="checkbox"/> 0 – 1 year | <input type="checkbox"/> 6 – 9 years |
| <input type="checkbox"/> 2 - 3 years | <input type="checkbox"/> 10 – 15 years |
| <input type="checkbox"/> 4 – 5 years | <input type="checkbox"/> 16 or more years |



9. Which **best describes** your current home? (check one)

- | | |
|--|--|
| <input type="checkbox"/> single-family home | <input type="checkbox"/> house boat |
| <input type="checkbox"/> town house / duplex | <input type="checkbox"/> mobile home |
| <input type="checkbox"/> condominium | <input type="checkbox"/> other (describe: _____) |

10. For how many years have you been **in your current home**?

- | | |
|--------------------------------------|---|
| <input type="checkbox"/> 0 – 1 year | <input type="checkbox"/> 6 – 9 years |
| <input type="checkbox"/> 2 - 3 years | <input type="checkbox"/> 10 – 15 years |
| <input type="checkbox"/> 4 – 5 years | <input type="checkbox"/> 16 or more years |

11. Do you **have pets**? ☐ no ☐ yes

If yes, what kind of animal(s) and how many? (*e.g., 2 dogs and 1 cat*)

12. How **many bedrooms** does your home have? (circle one) [1] [2] [3] [4] [5] [6+]

13. How **many bathrooms** does your home have? (circle one) [1] [1½] [2] [2½] [3+]

14. How **many floors** does your home have?

- | | | |
|---------------------------------------|---------------------------------------|------------------------------------|
| <input type="checkbox"/> 1 | <input type="checkbox"/> 2 + basement | <input type="checkbox"/> 4 or more |
| <input type="checkbox"/> 1 + basement | <input type="checkbox"/> 3 | |
| <input type="checkbox"/> 2 | <input type="checkbox"/> 3 + basement | |

15. What is your home's approximate **size in square feet**? _____ sq. ft.

16. What do you do to **keep your house cool** in summer? (check all that apply)

- | | |
|--|---|
| <input type="checkbox"/> open the windows | <input type="checkbox"/> use air conditioning |
| <input type="checkbox"/> use a ceiling fan(s) | <input type="checkbox"/> keep sunlight out (e.g., close the blinds) |
| <input type="checkbox"/> use a portable fan(s) | <input type="checkbox"/> other (describe: _____) |

17. What **kind of heat** do you have? (check all that apply)

- | | |
|-----------------------------------|--|
| <input type="checkbox"/> gas | <input type="checkbox"/> solar |
| <input type="checkbox"/> electric | <input type="checkbox"/> other (describe: _____) |
| <input type="checkbox"/> oil | <input type="checkbox"/> don't know |

18. **How many people** live in your current home (including yourself)? _____



19. When it's time to replace a **major household appliance** (e.g., the refrigerator), who makes the decision? (check one)

- ☐ I do
- ☐ my spouse/partner does
- ☐ my spouse/partner and I share the responsibility
- ☐ Other (Who? _____)

20. Who in your household is **responsible for the following**? (circle all that apply)

Meal preparation: [I am] [my spouse/partner] [my child(ren)] [someone else]

Laundry: [I am] [my spouse/partner] [my child(ren)] [someone else]

House cleaning: [I am] [my spouse/partner] [my child(ren)] [someone else]

Yard work: [I am] [my spouse/partner] [my child(ren)] [someone else]

Paying the bills: [I am] [my spouse/partner] [my child(ren)] [someone else]

do you (or they) ever use automatic bill pay? ☐ no ☐ yes ☐ don't know

21. Do you regularly **water your lawn**? ☐ I don't have a lawn ☐ no ☐ yes

If yes, how do you water it? (check all that apply)

- ☐ by hand with a hose
- ☐ hose with sprinkler attachment
- ☐ automatic sprinkler
- ☐ other (describe: _____)

22. When you **leave the house**, how often do you...

Drive: [frequently] [occasionally] [rarely] [never]

Bike: [frequently] [occasionally] [rarely] [never]

Walk: [frequently] [occasionally] [rarely] [never]

Take public transportation: [frequently] [occasionally] [rarely] [never]

23. If you drive, what **type of vehicle** do you drive? [compact] [sedan] [wagon] [SUV] [van] [other]

What **type of fuel** does your car use? [gas] [electric] [gas+electric] [diesel] [other]

If gas, **how many miles/gallon** does your vehicle get? _____

24. Do you ever use **automatic timers** on your lights and/or appliances (e.g., to give the house a "lived-in" look while you're out of town)? ☐ no ☐ yes

If yes, who sets up the timers? ☐ I do ☐ my spouse/partner ☐ someone else



25. Which of the following do you **have in your house?** (check all that apply)

- ☐ **Security/alarm system**
- ☐ **Intercom system:** where (circle all that apply)? [for front door] [throughout the house]
- ☐ **CD Player**
- ☐ **Television(s):** how many? [1] [2] [3] [4] [5+]
- ☐ **VCR:** used to (circle all that apply)... [play movies/TV shows] [record movies/TV shows]
- ☐ **DVD Player**
- ☐ **Surround sound stereo system**
- ☐ **Digital Video Recorder:** which (circle one)? [TiVo] [Replay TV] [Other _____]
- ☐ **Cable TV:** what kind (circle one)? [digital] [analog]
- ☐ **Video Game System (e.g., Xbox, Sony Playstation)**
- ☐ **Stackable washer/dryer (not separate machines)**
- ☐ **Washing machine (not part of stackable unit):** what kind? [top loading] [front loading]
- ☐ **Clothing Dryer (not part of stackable unit):** what kind? [top loading] [front loading]
- ☐ **Dishwasher:** what kind? [built-in] [portable] [tabletop]
- ☐ **Air conditioning:** what kind? [central a/c] [window unit(s)] [portable unit(s)]
- ☐ **Full-sized Refrigerator:** what kind? [side-by-side] [top freezer] [bottom freezer] [other]
- ☐ **Compact or portable refrigerator(s) :** how many? _____
- ☐ **Stand-alone Freezer:** what kind? [upright] [chest] [other]
- ☐ **Microwave oven** what kind? [built-in] [countertop]
- ☐ **Portable / space heater:** how many? _____
- ☐ **Hot water heater/tank:** how many? _____

26. If you use a VCR or Digital Video Recorder (TiVo/Replay TV) **to record** TV shows/movies, **who sets up** the recordings? (check all that apply)

- ☐ I do
- ☐ my child(ren)
- ☐ my spouse/partner
- ☐ someone else (who? _____)

27. When an electronic device (e.g., the computer) **breaks or you're having difficulty** using it, what are you most likely to do? (check all that apply)

- ☐ this doesn't happen to me
- ☐ read the owner's manual
- ☐ look for help online
- ☐ contact customer service
- ☐ hire a consultant / professional
- ☐ ask spouse / partner to help
- ☐ ask child(ren) to help
- ☐ call a relative/friend (who doesn't live with you) to help
- ☐ purchase a replacement
- ☐ other (describe: _____)



28. Do you **use a computer** (desktop or laptop) regularly? ☐ no ☐ yes

If yes...

for what do you use it (check all that apply)? ☐ personal use ☐ work use

do you have a computer **at home**? ☐ no ☐ yes (how many? _____)

do you have a computer **at work**? ☐ no ☐ yes

29. Where do you **regularly use the internet** (personal or work use)? (check all that apply)

☐ I don't use the internet

☐ Work / the office

☐ Home

☐ Public place (e.g., a library, internet café)

30. If you use the **internet at home**,

What **kind of connection** do you have?

☐ 28.8k modem

☐ 56k modem

☐ High Speed: what kind (circle one)? [DSL] [Cable Modem] [T1] [T3] [other]

☐ Other (describe: _____)

☐ I don't know

Do you have a **wireless network**? ☐ no ☐ yes ☐ don't know

31. How often do you **use or do** the following (personal or work use)?

eMail: [frequently] [occasionally] [rarely] [never]

Internet: [frequently] [occasionally] [rarely] [never]

Voice Mail: [frequently] [occasionally] [rarely] [never]

Online banking: [frequently] [occasionally] [rarely] [never] [what's that?]

Electronic calendar/schedule: [frequently] [occasionally] [rarely] [never] [what's that?]

Self-checkout at the store: [frequently] [occasionally] [rarely] [never] [what's that?]

Purchase from web sites: [frequently] [occasionally] [rarely] [never] [what's that?]

Text messaging: [frequently] [occasionally] [rarely] [never] [what's that?]

Computer or laptop: [frequently] [occasionally] [rarely] [never] [don't have one]

Answering machine: [frequently] [occasionally] [rarely] [never] [don't have one]

Cell phone: [frequently] [occasionally] [rarely] [never] [don't have one]

do you save phone numbers on your cell phone? ☐ no ☐ yes

PDA—e.g., Palm Pilot: [frequently] [occasionally] [rarely] [never] [don't have one] [what's that?]

MP3 player: [frequently] [occasionally] [rarely] [never] [don't have one] [what's that?]



32. How **old is the refrigerator** in your home?

☐ 0 - 2 years

☐ 11 – 15 years

☐ 3 – 5 years

☐ 16 years or more

☐ 6 – 10 years

☐ I don't know

33. Could you accurately guess (within \$10) **your average monthly energy bill for summer or winter** without having to look it up or ask someone else? ☐ no ☐ yes ☐ don't know

34. Do you ever wish you knew **how much a particular item or appliance contributes** to your utility bill(s)? (e.g., how much the treadmill is costing you each month, how much the extra daily shower in summer adds to the bill) ☐ no ☐ yes

If yes, **which item or appliance** and **what do you want to know** about it?

35. What **most motivates you** to save energy that comes from public utilities (e.g., gas, electricity, water) at home? (check one)

☐ save money

☐ reduce dependency on foreign energy sources

☐ conserve natural resources

☐ reduce pollution

☐ to make my home more comfortable

☐ set a good example for others (e.g., your children)

☐ other (please include: _____)

☐ *I am not motivated to save energy*

36. What do you think the best way to **save energy from public utilities** at home is?



Instructions: Please circle the item on the scale that best approximates your level of agreement with each statement. **Energy refers to energy provided by public utilities** (e.g., gas, electricity, water)

I would like to know...

... where energy is used in my household	<i>strongly disagree</i>	<i>disagree</i>	<i>not sure</i>	<i>agree</i>	<i>strongly agree</i>
... suggestions about which appliances I should replace to save energy	<i>strongly disagree</i>	<i>disagree</i>	<i>not sure</i>	<i>agree</i>	<i>strongly agree</i>
... suggestions about which light bulbs I should replace to save energy	<i>strongly disagree</i>	<i>disagree</i>	<i>not sure</i>	<i>agree</i>	<i>strongly agree</i>
... suggestions about when my appliances need maintenance to be more energy efficient	<i>strongly disagree</i>	<i>disagree</i>	<i>not sure</i>	<i>agree</i>	<i>strongly agree</i>
... suggestions about what I could do differently to be more energy efficient	<i>strongly disagree</i>	<i>disagree</i>	<i>not sure</i>	<i>agree</i>	<i>strongly agree</i>
... suggestions about what all members of my household could do differently to be more energy efficient	<i>strongly disagree</i>	<i>disagree</i>	<i>not sure</i>	<i>agree</i>	<i>strongly agree</i>
... how energy is used in my household compared to similar households in my local area	<i>strongly disagree</i>	<i>disagree</i>	<i>not sure</i>	<i>agree</i>	<i>strongly agree</i>
... how energy is used in my household compared to similar households throughout the country	<i>strongly disagree</i>	<i>disagree</i>	<i>not sure</i>	<i>agree</i>	<i>strongly agree</i>
... how my household's energy use affects the environment	<i>strongly disagree</i>	<i>disagree</i>	<i>not sure</i>	<i>agree</i>	<i>strongly agree</i>

37. If you could know **anything else** about how energy from public utilities is used in your household, what would you want to know?

Thank you!

Please return this questionnaire to Chris



Appendix B:

Recruiting flyer

Are you a homeowner? *Spend an hour* to help us make technology more user-friendly.

Intel Research Seattle is exploring how technology can *help reduce home energy use*. **This is not for marketing purposes.** We are looking for **homeowners** who are willing to come to our lab in the U-District to participate in a short study to help make the technology more user-friendly. The study will take about **one hour** and is being conducted between **June 26 and July 3**. As a thank-you, participants will receive **\$25 cash**. If you are interested in participating, or want to learn more, please contact Chris Beckmann by phone at 206.545.2528 or by email at beckmann@intel-research.net.

Home Energy Use Study
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Appendix C:

Consent paperwork



Home Energy Tutor Study Participant Release Form Phase 2 (In-lab Paper-based Study)

Thank you for your willingness to participate in Intel's study of sensor configuration for home-based technology. We are investigating tools that could be used by home owners to set up ubiquitous computing environments/applications in their homes. We will ask you about your and your family's familiarity with technology, energy use, home appliances, activities, habits, and information needs. The video, audio, and photographs we take will be part of a research archive of work in ubiquitous computing environments for people around the world. We will use a fake name to protect your identity. **Your real name will be kept confidential.**

We do not intend to share these archival materials with anyone not involved in this research. However, we may want to show or use specific parts of these materials in research presentations or publications—perhaps at conferences, in university classrooms, in books, on websites, or with companies and organizations with whom we collaborate. In all cases, **your name will be kept confidential.**

During our talks, feel free to ask us to stop recording at any time, or to delete any recorded materials. Furthermore, in order for us to protect your ideas, please do not discuss with us any of your personal plans, inventions, or patents which you feel you may pursue in the future, or to which you may not want us to have access.

If you have questions or concerns about this permission form or our session, contact Sunny Consolvo, Member of Research Staff, at 206-545-2529.

By signing this form, you agree that:

- You have read and understood it, and agree to its conditions;
- Your participation in this study is completely voluntary;
- Your name will be kept confidential;
- The media recorded during this visit become the property of Intel Corporation for use in this research and possible inclusion in research publications, presentations, and websites;
- You are not revealing any of your own private product concepts, inventions, or ideas that you may want to develop in the future;
- You are being given a blank copy of this form to keep.

X

Signature (of primary participant)

Name Printed

Date

Signature (of other participant)

Name Printed

Date

Signature (of other participant)

Name Printed

Date

Intel Research Seattle
1100 NE 45th Street
6th Floor
Seattle, WA 98105



CASH INCENTIVE RECEIPT
Home Energy Tutor Configuration Tool, Phase 2

I, the undersigned, do hereby acknowledge receipt of \$25 from Intel Research Seattle on this date for my participation in the *Intel Research Seattle Home Energy Tutor Configuration Tool In-lab paper-based study*. Payment made in the form of cash.

Date: X _____, 2003

X _____
Signature

X _____
Print name

The information below is for record keeping purposes only. Your information will be kept confidential.

Mailing address: X _____

Daytime phone: X (____) _____-

Appendix D:

Item catalog

Item Catalog

Table of Contents

Refrigerators and Freezers

Dishwashers

Microwaves

Washers and Dryers

Water heaters

Televisions

Toasters

Rooms

Refrigerators and Freezers

Top-freezer refrigerator

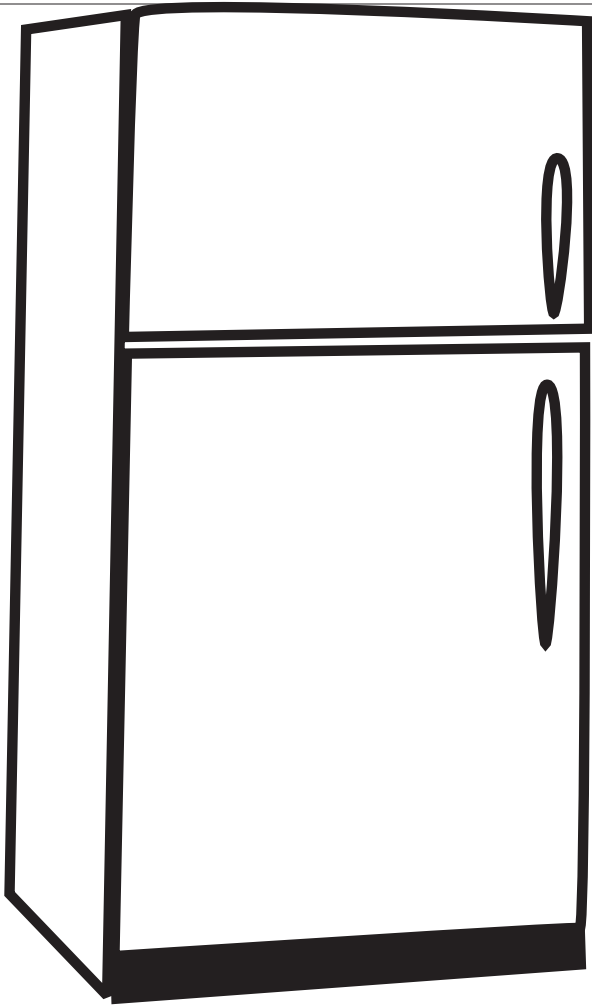
Bottom-freezer refrigerator

Side-by-side refrigerator

Compact refrigerator

Chest freezer

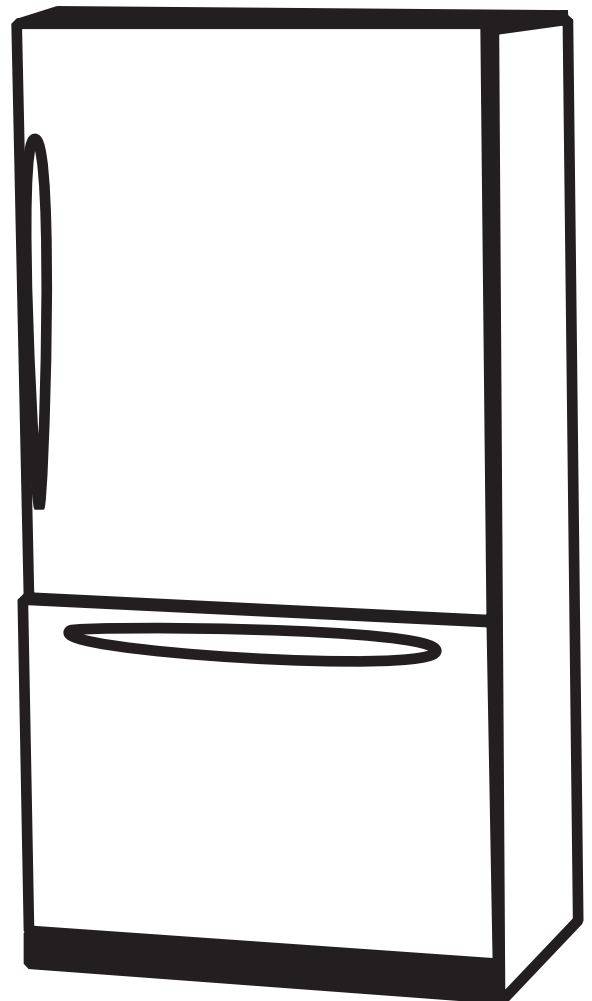
Upright freezer

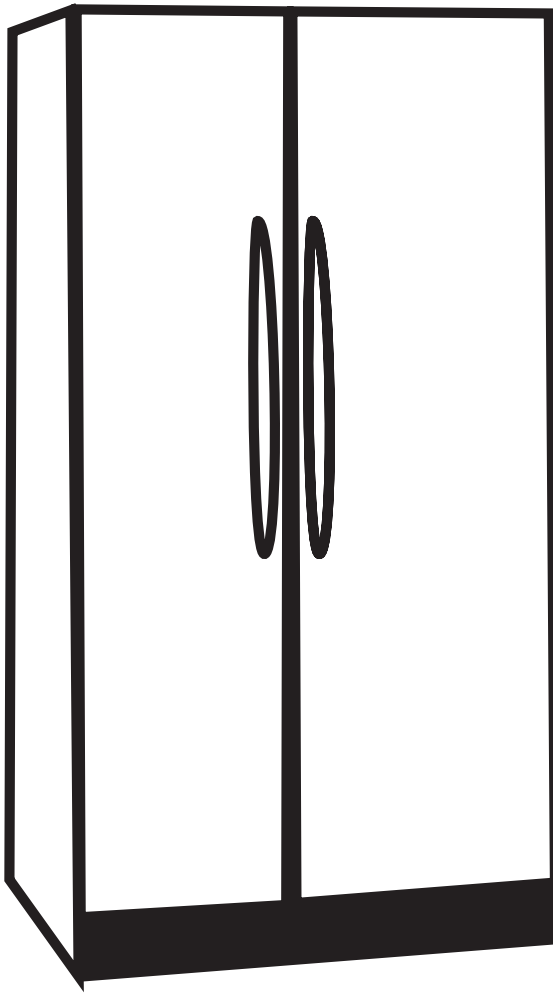


Top-freezer refrigerator



Bottom-freezer refrigerator

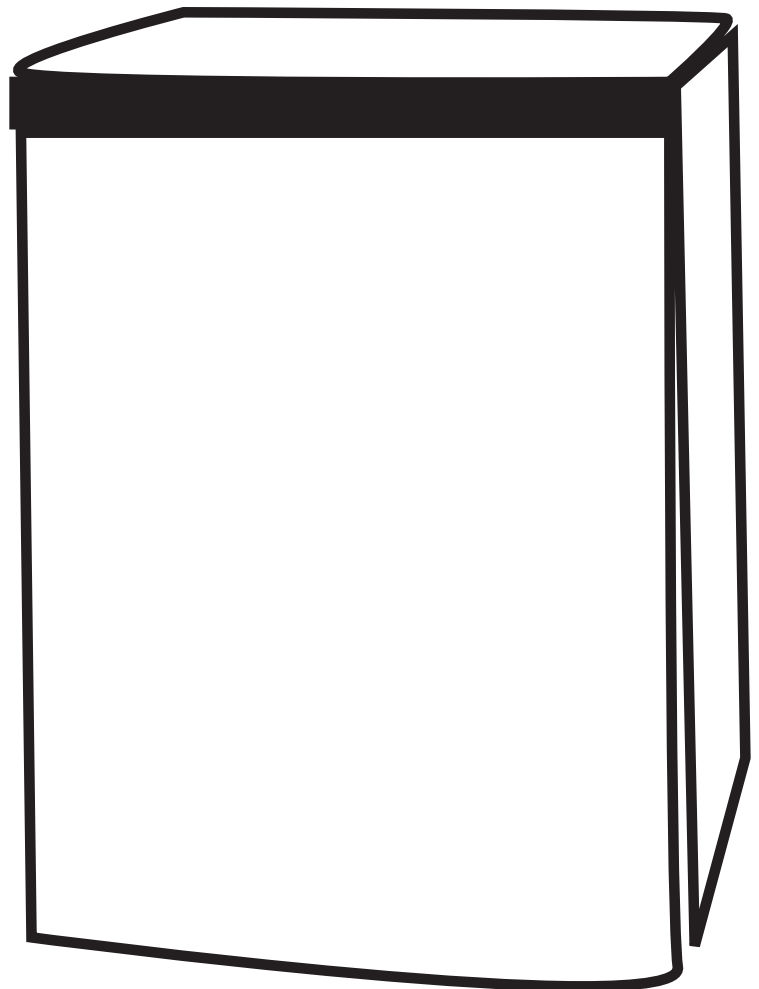


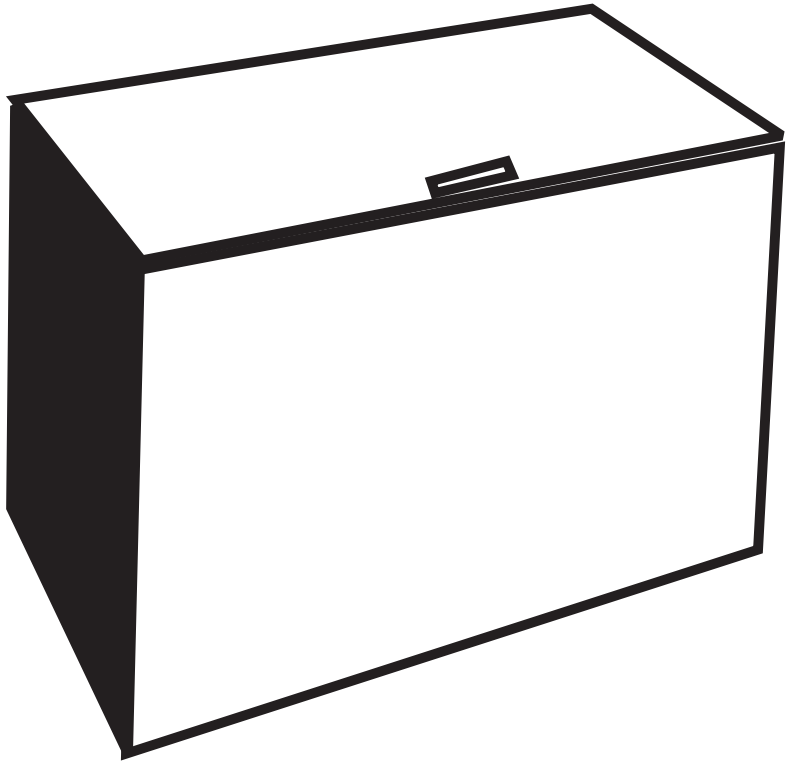


Side-by-side refrigerator



Compact refrigerator

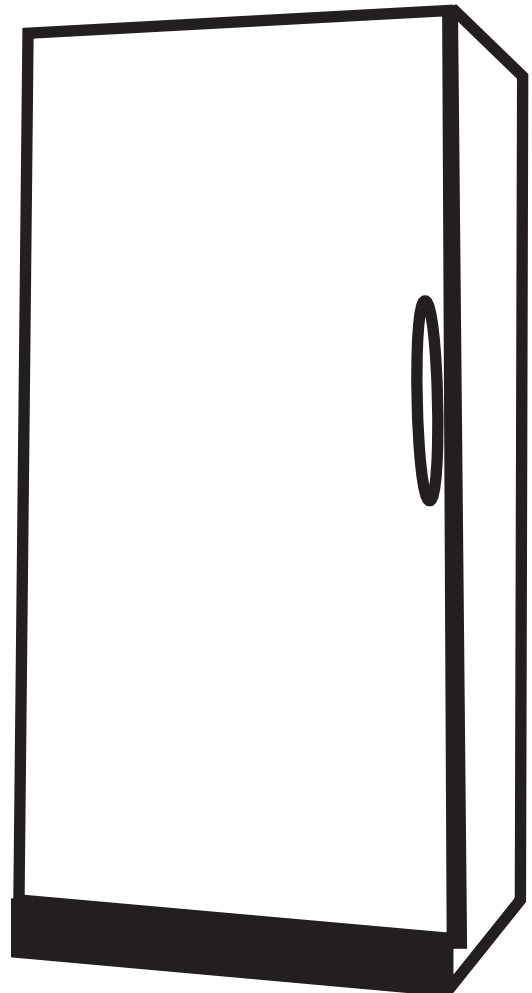




Chest freezer



Upright freezer



Dishwashers

Built-in dishwasher

Portable dishwasher

Tabletop dishwasher

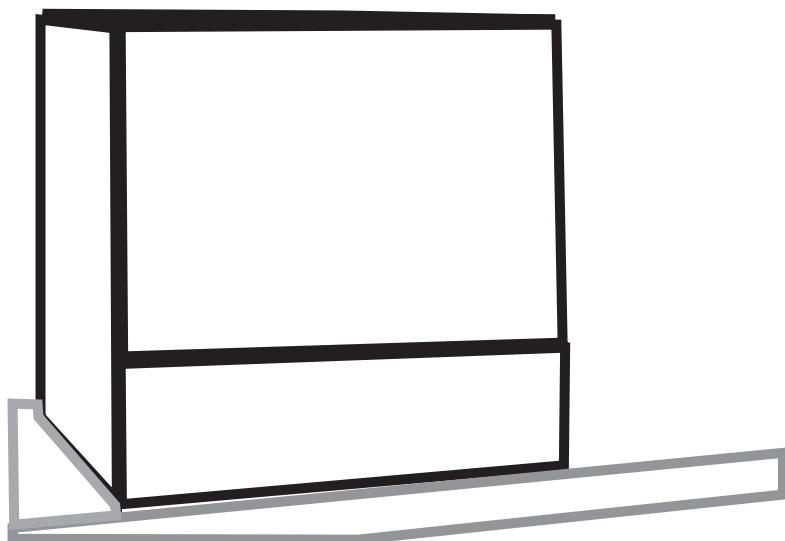


Built-in dishwasher



Portable dishwasher



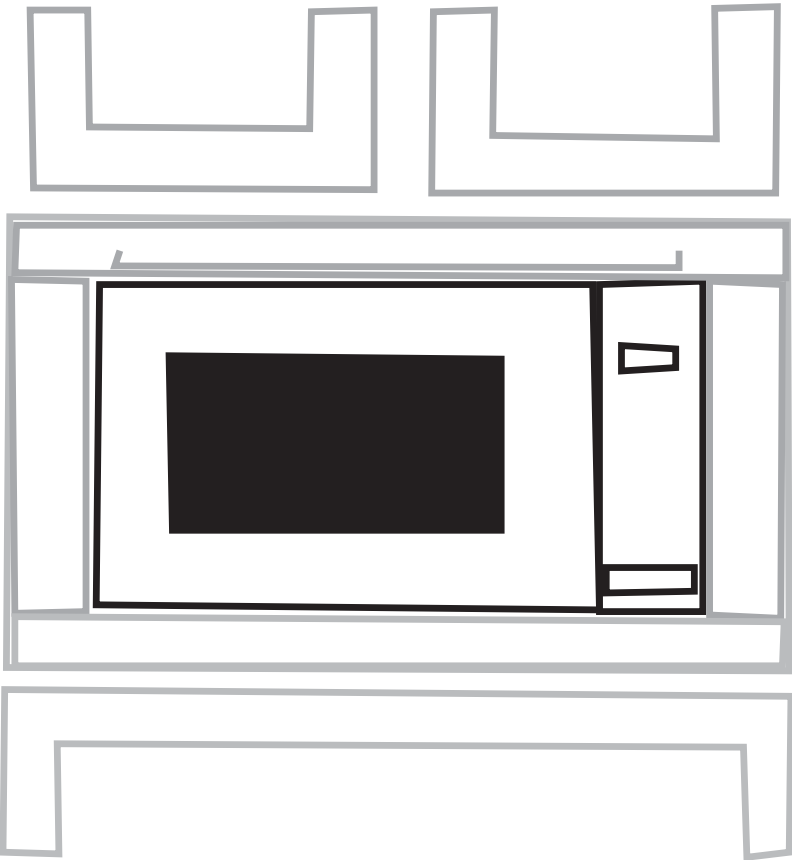


Tabletop dishwasher

Microwaves

Built-in microwave

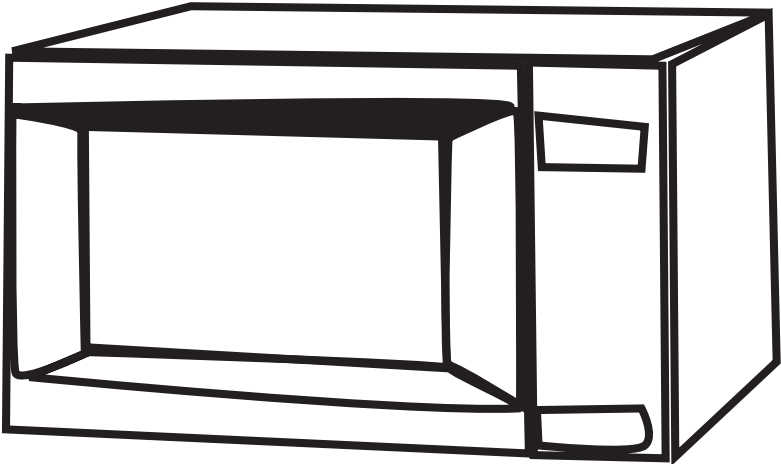
Countertop microwave



Built-in microwave



Countertop microwave



Washers and Dryers

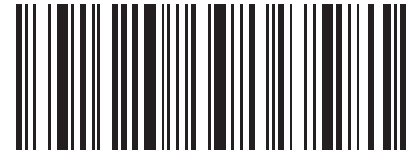
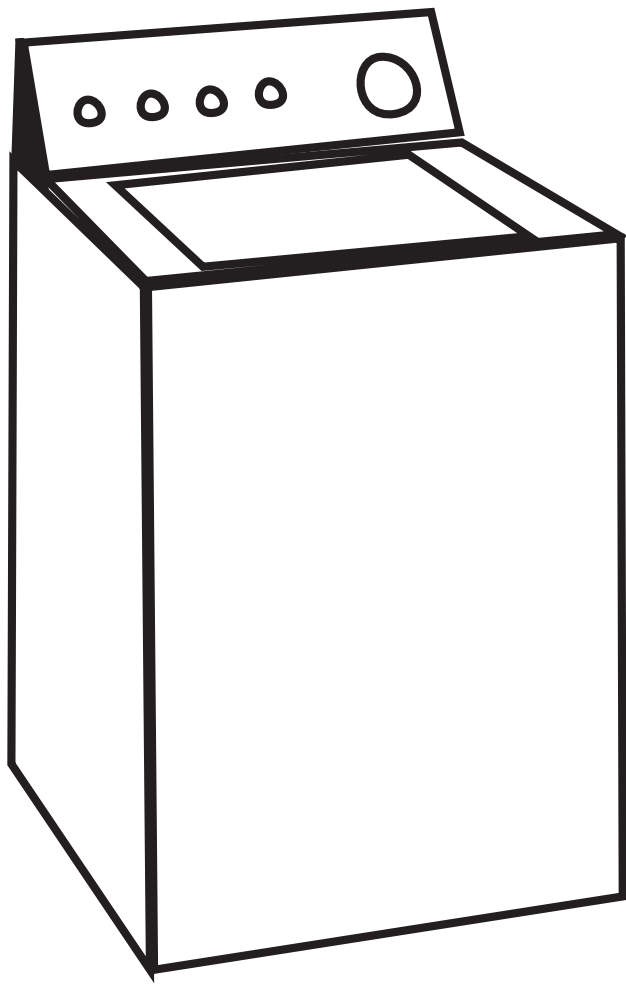
Top-loading washer

Front-loading dryer

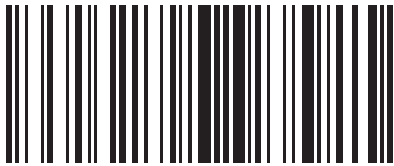
Front-loading washer

Top-loading washer-dryer

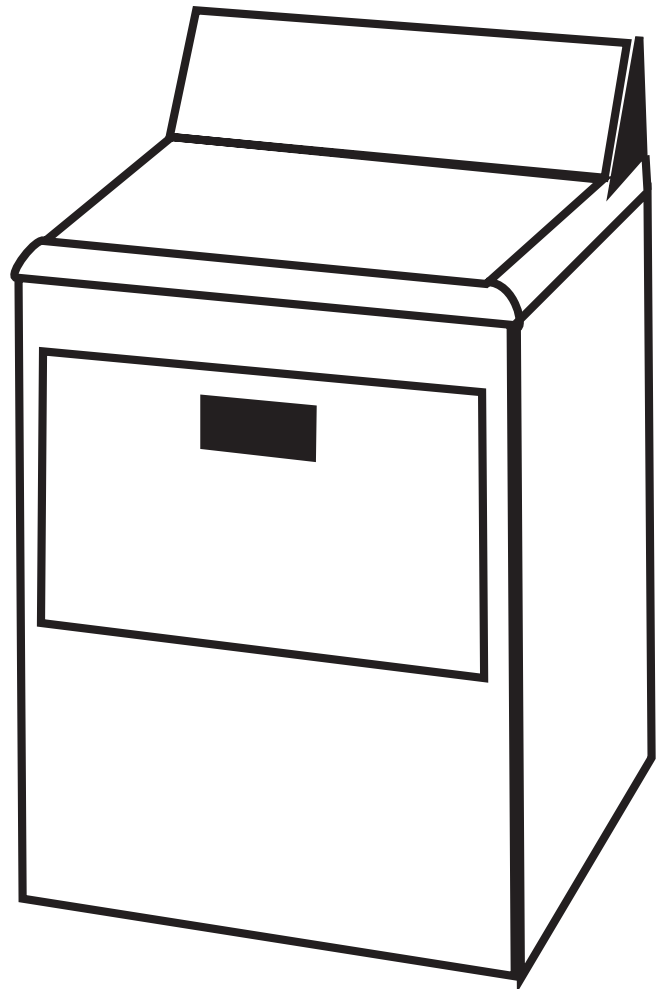
Front-loading washer-dryer

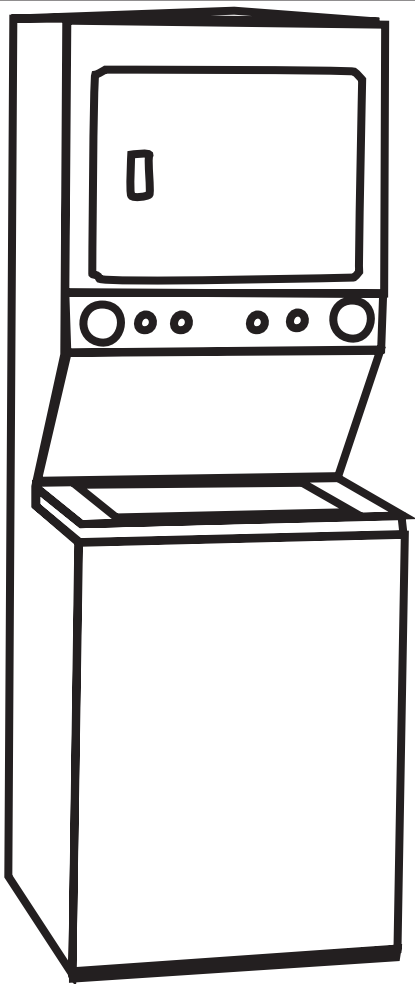


Top-loading washer



Front-loading dryer

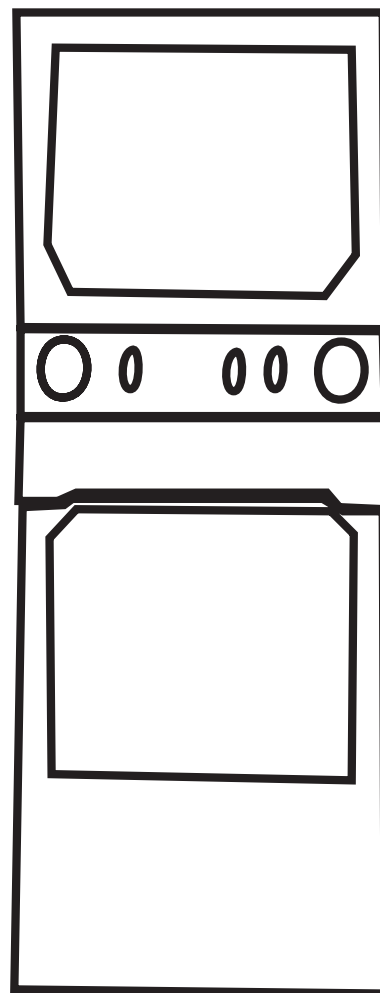




Top-loading washer-dryer



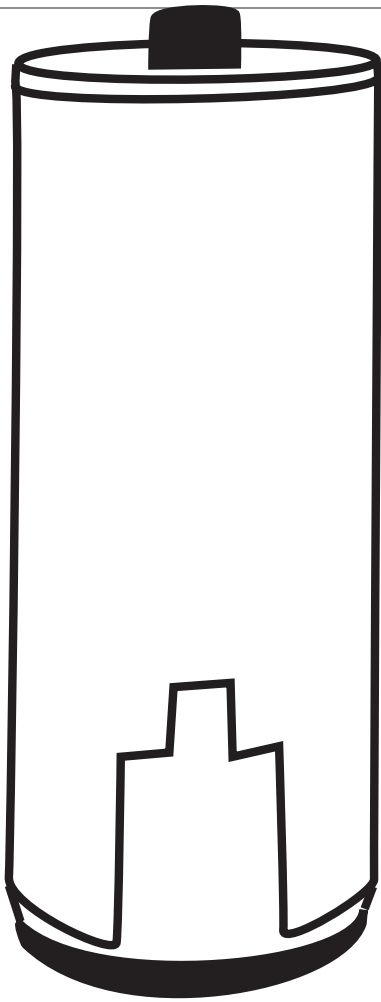
Front-loading washer-dryer



Water heaters

Tank water heater

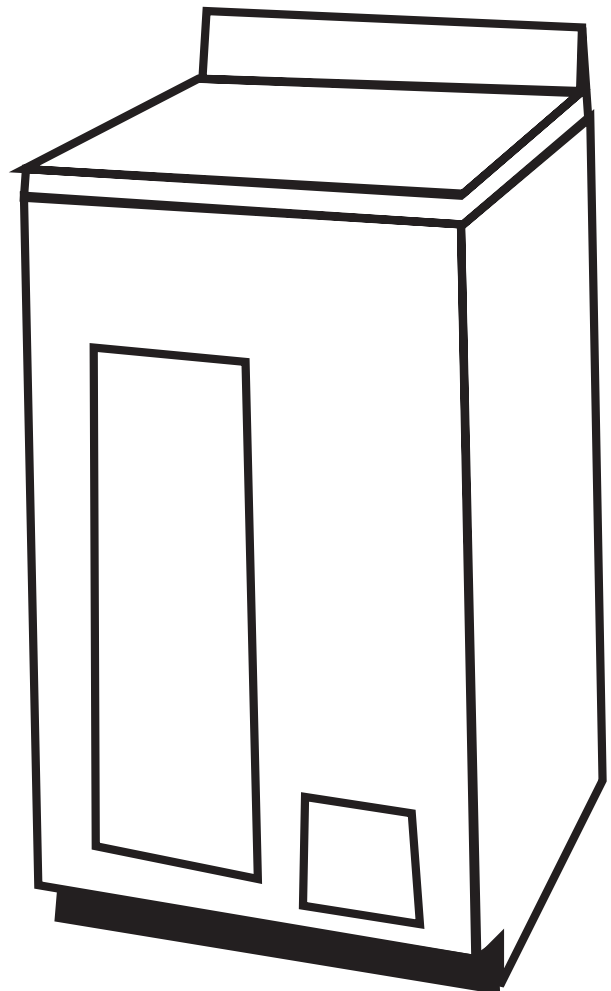
Tabletop water heater



Tank water heater



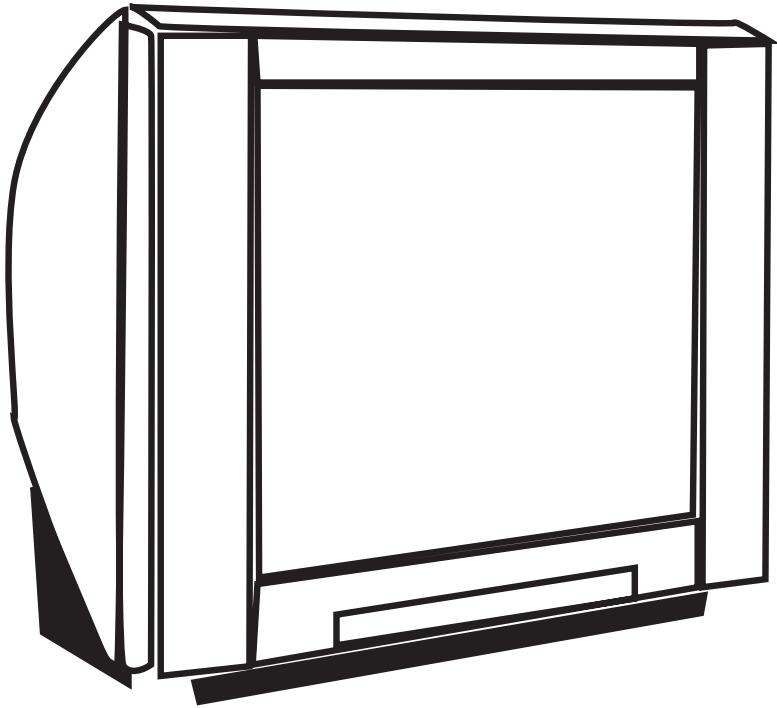
Tabletop water heater



Televisions

Standard television

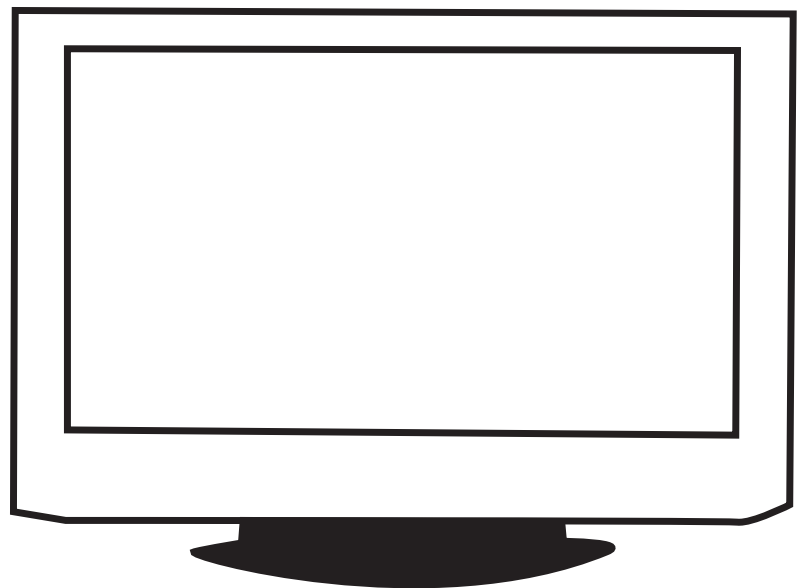
Plasma television



Standard television



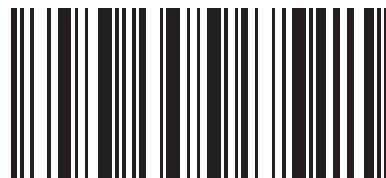
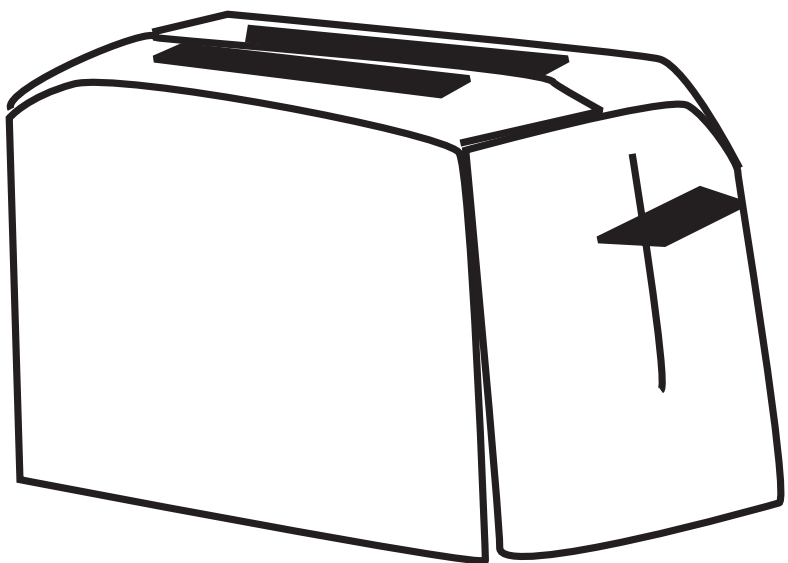
Plasma television



Toasters

Toaster

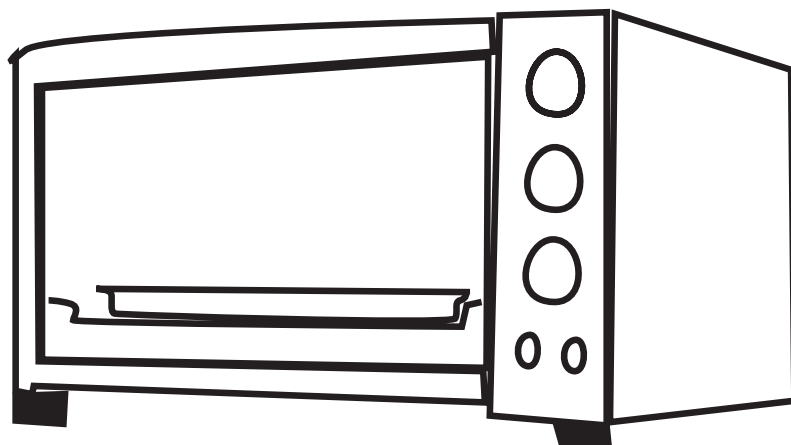
Toaster oven



toaster



toaster oven



Rooms

Bathrooms **x 5**

Bedrooms **x 5**

Family room

Kitchen

Living room

Dining room

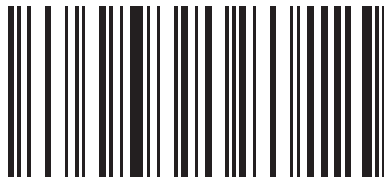
Basement



family room



dining room



kitchen



living room



basement



_____ bathroom



_____ bathroom



_____ bathroom



_____ bathroom



_____ bathroom



_____ bedroom



_____ bedroom



_____ bedroom



_____ bedroom



_____ bedroom

Appendix E:

Quick start guide

Quick Start Guide

Home Energy Tutor

To allow the Home Energy Tutor to track your household activity and energy usage, you will need to label your appliances and rooms with sensors. *Labeling* an appliance or room means **physically installing** a sensor, and then **indicating** where the sensor has been installed. Setting up the Home Energy Tutor **does not require** a technical background.

To label, you will need the following items from the Home Energy Tutor kit:

- **Handheld Scanner**
- **Sensors** (types **C**, **V**, and **M**)
- **Item Catalog**

To label your home, follow these steps:

1. Turn on the Handheld Scanner

- use the **green** button on the top right of the handheld

2. Select ‘Label home’ from the main screen

- use your finger or the stylus to make selections on the handheld

3. Label an appliance or room

- To label **an appliance**:
 - **Find the item** in the **Item Catalog** that most closely matches the one you want to label
 - If no items match the item you want to label, write in the name of the item next to an unnamed barcode
 - **Scan the barcode** for that item
 - Hold down the **black** button in the upper left of the handheld to scan

- To label **a room**:
 - **Find the room name** in the **Item Catalog** that most closely matches the room you want to label
 - If no room names match the room you want to label, write in the name of the room next to an unnamed barcode
 - **Scan the barcode** for that room
 - Hold down the **black** button in the upper left of the handheld to scan
- 4. **Follow the directions onscreen** to install the sensor.
- 5. **Repeat steps 3 and 4** until you have labeled all of the appliances and rooms you want the Home Energy Tutor to track.

If you have difficulty labeling, refer to the **Instruction Manual** or the **Help Guide on the Handheld Scanner**.

Suggested appliances & rooms to label

For the Home Energy Tutor to be most effective, we recommend you label the following appliances and rooms.

Recommended Appliances:

- | | |
|-------------------|-----------------|
| ○ Refrigerator(s) | ○ Dryer |
| ○ Dishwasher | ○ Water heater |
| ○ Washing machine | ○ Television(s) |

Recommended Rooms:

- | | |
|--|------------------------|
| ○ Bedroom(s) | ○ Kitchen |
| ○ Bathroom(s) | ○ Laundry/Utility Room |
| ○ Living Room | ○ Den/Home Office |
| ○ Dining Room | ○ Exercise Room |
| ○ any other rooms you or your family use regularly | |
| ○ IMPORTANT: The Home Energy Tutor uses this information to provide recommendations on where it would | |

be most cost effective for you to invest in energy efficient upgrades. If you do not label all of the areas of your home that are used regularly, the recommendations will be less valuable. The more areas you label, the better the recommendations.

Other:

- If you are curious about other appliances or rooms, you can label them with any remaining sensors. If the appliance or room you wish to label isn't in the Item Catalog, use the blank barcodes to write in your own description.
- Use **type C** sensors when you can easily access the appliance's power cord and outlet
- Use **type V** sensors for...
- Use **type M** sensors for...

Appendix F:

Kit contents list

Home Energy Tutor Kit Contents

This kit contains:

- (1) Item Catalog
- (1) Quick Start Guide
- ~~(1) Instruction Manual~~
- (1) Handheld Scanner
- (6) Sensors:
 - (2) **Type C** sensors
 - (2) **Type V** sensors
 - (2) **Type M** sensors

Refer to the Quick Start Guide to start installing the Home Energy Tutor.

Appendix G:

Scanning instructions

Scanning Items

Home Energy Tutor

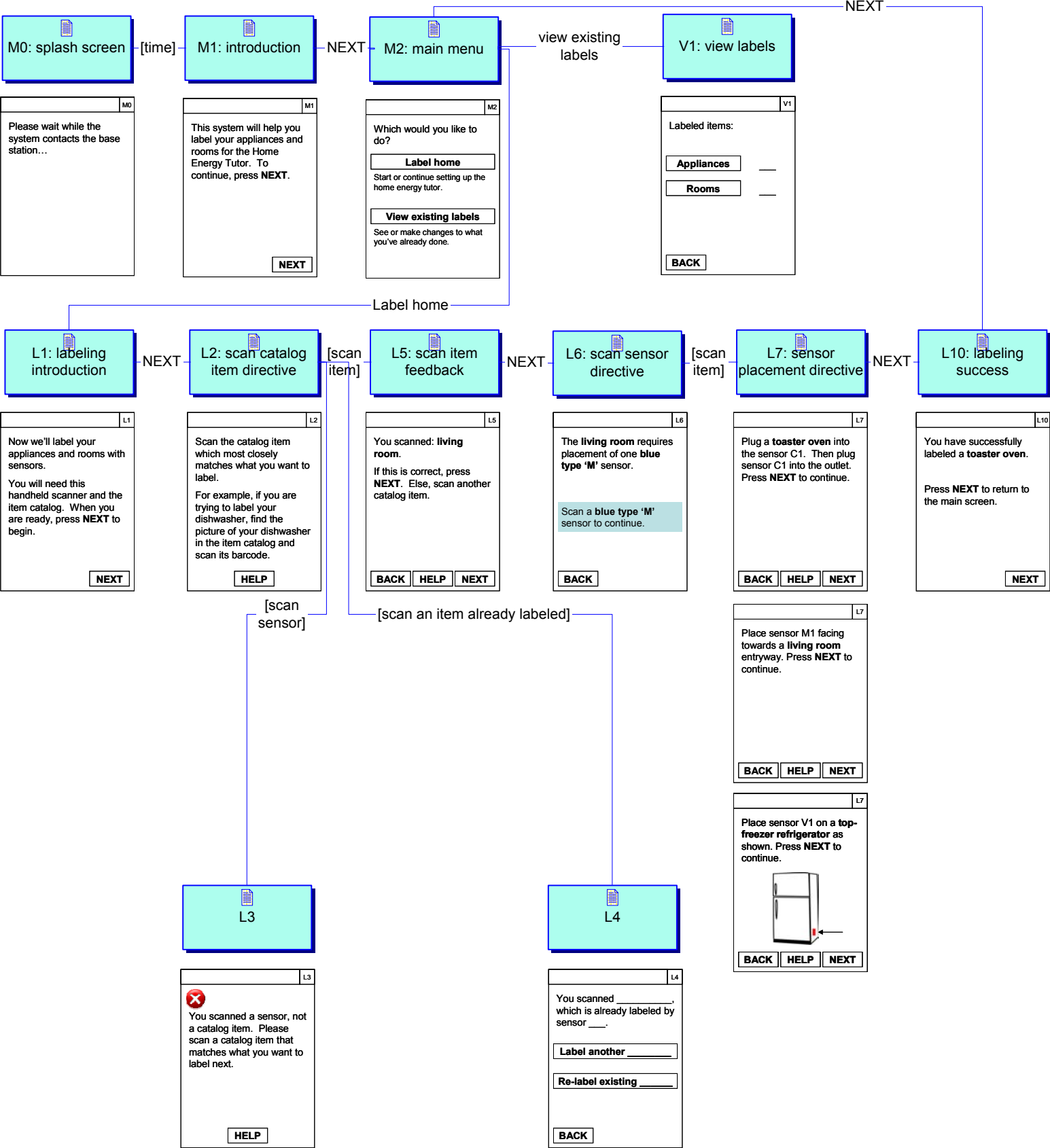
- Select an item from the Item Catalog to scan

- To scan the item:
 - Hold down the silver button on the upper left side of the handheld
 - IMPORTANT: press the middle of the button
 - When it is ready to scan, the scanner will emit a red horizontal line from the top of the handheld for approximately 3 seconds. If you do not see the line, press the button again
 - Aim the scanner approximately 6 inches from the barcode
 - If the scanner is too close to the barcode, it won't work
 - You will hear a beep when the barcode has been scanned

 - NOTE: It usually takes a little practice to successfully scan a barcode.

Appendix H:

Handheld scanner UI flow



Appendix I:

UI screen designs


	M0
<p>Please wait while the system contacts the base station...</p>	

	M1
<p>This system will help you label your appliances and rooms for the Home Energy Tutor. To continue, press NEXT.</p>	
<div>NEXT</div>	

	M2
<p>Which would you like to do?</p>	
<div>Label home</div>	
<p>Start or continue setting up the home energy tutor.</p>	
<div>View existing labels</div>	
<p>See or make changes to what you've already done.</p>	

	L1
<p>Now we'll label your appliances and rooms with sensors.</p>	
<p>You will need this handheld scanner and the item catalog. When you are ready, press NEXT to begin.</p>	
<div>NEXT</div>	

	L2
<p>Scan the catalog item which most closely matches what you want to label.</p>	
<p>For example, if you are trying to label your dishwasher, find the picture of your dishwasher in the item catalog and scan its barcode.</p>	
<div>HELP</div>	

	L3
<div></div>	
<p>You scanned a sensor, not a catalog item. Please scan a catalog item that matches what you want to label next.</p>	
<div>HELP</div>	

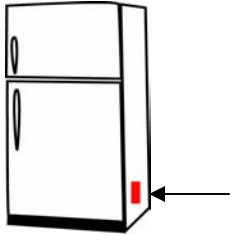
	L4
<p>You scanned _____, which is already labeled by sensor ____.</p>	
<div>Label another _____</div>	
<div>Re-label existing _____</div>	
<div>BACK</div>	

	L5
<p>You scanned: living room.</p>	
<p>If this is correct, press NEXT. Else, scan another catalog item.</p>	
<div>BACK</div>	
<div>HELP</div>	
<div>NEXT</div>	

	L6
<p>The living room requires placement of one blue type 'M' sensor.</p>	
<div>Scan a blue type 'M' sensor to continue.</div>	
<div>BACK</div>	

L7

Place sensor V1 on a **top-freezer refrigerator** as shown. Press **NEXT** to continue.



BACK

HELP

NEXT

L7

Place sensor M1 facing towards a **living room** entryway. Press **NEXT** to continue.

BACK

HELP

NEXT

L7

Plug a **toaster oven** into the sensor C1. Then plug sensor C1 into the outlet. Press **NEXT** to continue.

BACK

HELP

NEXT

L9

Labeling appliances and rooms with sensors lets the Home Energy Tutor track where and when your household uses energy.

The item catalog is a printed booklet that comes in the main box.

BACK

L10

You have successfully labeled a **toaster oven**.

Press **NEXT** to return to the main screen.

NEXT

V1

Labeled items:

Appliances

—

Rooms

—

BACK

Appendix J:

Questionnaire data

Personal information:

Participant ID:	A1
Gender:	Female
Age range:	36-40
Occupation:	software engineer
Employment status:	full-time employed
Marital status:	married

Household residents:

Owns a pet:	no
Type and number of pets:	NA
Number of children:	1
Ages of children:	1 year
Number of children living with you:	1
Number of household residents:	3

Home and homeownership:

City of residence:	Seattle, WA
Homeowner:	yes
Homeowner for how long:	2-3 years
Type of home:	single-family home
Length of residence at this home:	2-3 years
Number of bedrooms:	4
Number of bathrooms:	2.5
Number of floors:	2+basement
Size in square feet:	2700
Regularly water lawn:	no
Lawn irrigation method:	hose&hand / hose&sprinkler
Winter heating method:	oil
Summer cooling method:	open windows / portable fan / keep sun out / other: window fans

Division of household responsibilities:

This person is responsible for...

- | | |
|--|------------------------------|
| • Decisions about appliance replacement: | shared with spouse |
| • Meal preparation: | self / spouse / someone else |
| • Laundry: | self / someone else |
| • Housecleaning: | self / someone else |
| • Yard work: | self / spouse / someone else |
| • Bill payment: | self |

Use of transportation methods:

Uses this transportation method when leaving house...

- | | |
|-------------------|--------------|
| • Drive: | frequently |
| • Bike: | rarely |
| • Walk: | occasionally |
| • Public transit: | rarely |

Vehicle type:	sedan
Vehicle fuel type:	gas
Vehicle fuel mileage:	not sure

Appliances and electronics in the home:*Has this device or system in their home...*

- | | |
|--------------------------------------|------------------|
| • Security/alarm system: | no |
| • Intercom system (and type): | throughout house |
| • CD player: | yes |
| • Television (and number): | 2 |
| • VCR (and type of use): | play / record |
| • DVD player: | yes |
| • Surround sound stereo: | yes |
| • Digital video recorder: | no |
| • Cable TV (and type): | digital |
| • Video game system: | no |
| • Stackable washer/dryer: | no |
| • Washing machine (and type): | front loading |
| • Clothing dryer (and type): | front loading |
| • Dishwasher (and type): | built-in |
| • Air conditioning: | no |
| • Full-size refrigerator (and type): | bottom freezer |
| • Compact refrigerator: | no |
| • Stand-alone freezer: | no |
| • Microwave (and type): | built-in |
| • Portable heater (and number): | 2 |
| • Hot water heater (and number): | 1 |

Configuration and repair tasks:

Person who sets up VCR / digital video recorder:	self / spouse
Use automatic bill pay:	yes
Have automatic timers on lights/appliances:	yes
Person who sets up timers on lights/appliances:	self
Save numbers on cell phone:	yes
Contact when electronics break or you have difficulty using:	read manual / search online / customer service / hire a pro / ask spouse / call a relative or friend / purchase replacement

Computer ownership and use:

Use computer regularly:	yes
Use for what activity:	personal and work
Use at home (how many at home):	3
Use at work:	yes
Where internet used:	work and home
Internet connection at home:	cable modem
Wireless network at home:	no

Use of services and devices:

Frequency of use for the following...

- | | |
|------------------------------------|----------------|
| • Email: | frequently |
| • Internet: | frequently |
| • Voice mail: | occasionally |
| • Online banking: | frequently |
| • Electronic calendar or schedule: | frequently |
| • Self-checkout at store: | rarely |
| • Purchasing from websites: | frequently |
| • Text messaging: | never |
| • Computer or laptop: | frequently |
| • Answering machine: | frequently |
| • Cell phone: | frequently |
| • PDA: | don't have one |
| • MP3 player: | rarely |

Information about energy use:

Knows age of refrigerator at home (how old):

3-5

Can guess monthly energy bill for a given season:

"I would like to analyze all of my appliances and learn what I can."

Would like to know about...

- | | |
|---|----------------|
| • Where energy is used in household: | strongly agree |
| • Appliances to replace for energy savings: | strongly agree |
| • Light bulbs to replace for energy savings: | strongly agree |
| • Appliance maintenance for energy savings: | strongly agree |
| • Personal behavior change for energy savings: | strongly agree |
| • Residents' behavior change for energy savings: | strongly agree |
| • Comparison of energy use to other local households: | agree |
| • Comparison of energy use to national households: | agree |
| • Household energy use affect on environment: | strongly agree |

Want to know about energy usage for an appliance:

yes

What appliances/energy information:

all appliances

Any other info about public utility energy usage:

NA

Top motivation to save energy from public utilities:

conserve natural resources

Best way to save energy from public utilities:

"Insulate home, turn off temperature control in unused areas, program vacations or daily periods when the home is not being used into heat / a / c timer. Hm. I guess I'm focusing on heat & a / c."

Personal information:

Participant ID:	A2
Gender:	Female
Age range:	27-30
Occupation:	program / research manager
Employment status:	full-time employed
Marital status:	married

Household residents:

Owns a pet:	no
Type and number of pets:	NA
Number of children:	0
Ages of children:	NA
Number of children living with you:	NA
Number of household residents:	2

Home and homeownership:

City of residence:	Seattle, WA
Homeowner:	yes
Homeowner for how long:	2-3 years
Type of home:	single-family home
Length of residence at this home:	2-3 years
Number of bedrooms:	4
Number of bathrooms:	2
Number of floors:	2+basement
Size in square feet:	2600
Regularly water lawn:	yes
Lawn irrigation method:	hose&hand / hose&sprinkler
Winter heating method:	gas
Summer cooling method:	open windows / portable fan / keep sun out

Division of household responsibilities:

This person is responsible for...

- | | |
|--|--------------------|
| • Decisions about appliance replacement: | shared with spouse |
| • Meal preparation: | self / spouse |
| • Laundry: | self / spouse |
| • Housecleaning: | self / spouse |
| • Yard work: | self / spouse |
| • Bill payment: | spouse |

Use of transportation methods:

Uses this transportation method when leaving house...

- | | |
|-------------------|--------------|
| • Drive: | occasionally |
| • Bike: | rarely |
| • Walk: | frequently |
| • Public transit: | frequently |

Vehicle type:	sedan
Vehicle fuel type:	gas
Vehicle fuel mileage:	20

Appliances and electronics in the home:*Has this device or system in their home...*

- | | |
|--------------------------------------|---------------|
| • Security/alarm system: | no |
| • Intercom system (and type): | no |
| • CD player: | yes |
| • Television (and number): | 2 |
| • VCR (and type of use): | yes |
| • DVD player: | yes |
| • Surround sound stereo: | yes |
| • Digital video recorder: | TiVo |
| • Cable TV (and type): | digital |
| • Video game system: | yes |
| • Stackable washer/dryer: | no |
| • Washing machine (and type): | top loading |
| • Clothing dryer (and type): | front loading |
| • Dishwasher (and type): | built-in |
| • Air conditioning: | no |
| • Full-size refrigerator (and type): | top freezer |
| • Compact refrigerator: | no |
| • Stand-alone freezer: | no |
| • Microwave (and type): | countertop |
| • Portable heater (and number): | no |
| • Hot water heater (and number): | 1 |

Configuration and repair tasks:

Person who sets up VCR / digital video recorder:	self / spouse
Use automatic bill pay:	yes
Have automatic timers on lights/appliances:	yes
Person who sets up timers on lights/appliances:	spouse
Save numbers on cell phone:	yes
Contact when electronics break or you have difficulty using:	customer service / spouse / call a relative or friend

Computer ownership and use:

Use computer regularly:	yes
Use for what activity:	personal and work
Use at home (how many at home):	1
Use at work:	yes
Where internet used:	work and home
Internet connection at home:	cable modem
Wireless network at home:	no

Use of services and devices:*Frequency of use for the following...*

- Email: frequently
- Internet: frequently
- Voice mail: occasionally
- Online banking: frequently
- Electronic calendar or schedule: occasionally
- Self-checkout at store: frequently
- Purchasing from websites: frequently
- Text messaging: rarely
- Computer or laptop: frequently
- Answering machine: frequently
- Cell phone: frequently
- PDA: don't have one
- MP3 player: don't have one

Information about energy use:

Knows age of refrigerator at home (how old): don't know
 Can guess monthly energy bill for a given season: no

Would like to know about...

- Where energy is used in household: agree
- Appliances to replace for energy savings: strongly agree
- Light bulbs to replace for energy savings: strongly agree
- Appliance maintenance for energy savings: strongly agree
- Personal behavior change for energy savings: agree
- Residents' behavior change for energy savings: agree
- Comparison of energy use to other local households: agree
- Comparison of energy use to national households: agree
- Household energy use affect on environment: agree

Want to know about energy usage for an appliance: yes
 What appliances/energy information: washer, dryer, computer, tivo
 Any other info about public utility energy usage: NA

Top motivation to save energy from public utilities: save money / conserve natural resources
 Best way to save energy from public utilities: "-turn off things which are not actively in use / -limit usage"

Personal information:

Participant ID:	A3
Gender:	Male
Age range:	31-35
Occupation:	sales
Employment status:	full-time employed
Marital status:	married

Household residents:

Owns a pet:	no
Type and number of pets:	NA
Number of children:	0
Ages of children:	NA
Number of children living with you:	NA
Number of household residents:	2

Home and homeownership:

City of residence:	Seattle, WA
Homeowner:	yes
Homeowner for how long:	2-3 years
Type of home:	single-family home
Length of residence at this home:	2-3 years
Number of bedrooms:	4
Number of bathrooms:	2
Number of floors:	2+basement
Size in square feet:	1610
Regularly water lawn:	yes
Lawn irrigation method:	hand&hose
Winter heating method:	gas
Summer cooling method:	open windows / portable fans / keep sun out

Division of household responsibilities:

This person is responsible for...

- | | |
|--|---------------|
| • Decisions about appliance replacement: | self / spouse |
| • Meal preparation: | self / spouse |
| • Laundry: | self / spouse |
| • Housecleaning: | self / spouse |
| • Yard work: | self / spouse |
| • Bill payment: | self / spouse |

Use of transportation methods:

Uses this transportation method when leaving house...

- | | |
|-------------------|--------------|
| • Drive: | occasionally |
| • Bike: | rarely |
| • Walk: | frequently |
| • Public transit: | frequently |

Vehicle type:	sedan
Vehicle fuel type:	gas
Vehicle fuel mileage:	20 city / 25 hwy

Appliances and electronics in the home:*Has this device or system in their home...*

- | | |
|--------------------------------------|---------------|
| • Security/alarm system: | no |
| • Intercom system (and type): | no |
| • CD player: | yes |
| • Television (and number): | 2 |
| • VCR (and type of use): | play / record |
| • DVD player: | yes |
| • Surround sound stereo: | yes |
| • Digital video recorder: | TiVo |
| • Cable TV (and type): | analog |
| • Video game system: | yes |
| • Stackable washer/dryer: | no |
| • Washing machine (and type): | top loading |
| • Clothing dryer (and type): | front loading |
| • Dishwasher (and type): | built-in |
| • Air conditioning: | no |
| • Full-size refrigerator (and type): | top freezer |
| • Compact refrigerator: | no |
| • Stand-alone freezer: | no |
| • Microwave (and type): | countertop |
| • Portable heater (and number): | 2 |
| • Hot water heater (and number): | 1 |

Configuration and repair tasks:

Person who sets up VCR / digital video recorder:	self / spouse
Use automatic bill pay:	yes
Have automatic timers on lights/appliances:	yes
Person who sets up timers on lights/appliances:	self
Save numbers on cell phone:	yes
Contact when electronics break or you have difficulty using:	read manual / search online / call a relative or friend

Computer ownership and use:

Use computer regularly:	yes
Use for what activity:	personal and work
Use at home (how many at home):	1
Use at work:	yes
Where internet used:	home and work
Internet connection at home:	cable modem
Wireless network at home:	no

Use of services and devices:*Frequency of use for the following...*

- Email: frequently
- Internet: frequently
- Voice mail: frequently
- Online banking: frequently
- Electronic calendar or schedule: frequently
- Self-checkout at store: occasionally
- Purchasing from websites: occasionally
- Text messaging: rarely
- Computer or laptop: frequently
- Answering machine: NA
- Cell phone: frequently
- PDA: never
- MP3 player: never

Information about energy use:

- Knows age of refrigerator at home (how old): don't know
- Can guess monthly energy bill for a given season: yes

Would like to know about...

- Where energy is used in household: strongly agree
- Appliances to replace for energy savings: agree
- Light bulbs to replace for energy savings: agree
- Appliance maintenance for energy savings: agree
- Personal behavior change for energy savings: strongly agree
- Residents' behavior change for energy savings: strongly agree
- Comparison of energy use to other local households: strongly agree
- Comparison of energy use to national households: strongly agree
- Household energy use affect on environment: agree

- Want to know about energy usage for an appliance: yes
- What appliances/energy information: "-water heater / -dishwasher / -washing machine / -dryer / -tv :: how much to operate?"
- Any other info about public utility energy usage: NA
- Top motivation to save energy from public utilities: save money
- Best way to save energy from public utilities: "Turn off appliances that aren't in use."

Personal information:

Participant ID:	A4
Gender:	Female
Age range:	27-30
Occupation:	accounts payable
Employment status:	full-time employed
Marital status:	single

Household residents:

Owns a pet:	yes
Type and number of pets:	2 cats
Number of children:	0
Ages of children:	NA
Number of children living with you:	NA
Number of household residents:	1

Home and homeownership:

City of residence:	Tukwila, WA
Homeowner:	yes
Homeowner for how long:	0-1 year
Type of home:	condominium
Length of residence at this home:	0-1 year
Number of bedrooms:	1
Number of bathrooms:	1
Number of floors:	1
Size in square feet:	530
Regularly water lawn:	don't have a lawn
Lawn irrigation method:	NA
Winter heating method:	electric
Summer cooling method:	open windows / use fan / keep sun out

Division of household responsibilities:

This person is responsible for...

- | | |
|--|--------------|
| • Decisions about appliance replacement: | self |
| • Meal preparation: | self |
| • Laundry: | self |
| • Housecleaning: | self |
| • Yard work: | someone else |
| • Bill payment: | self |

Use of transportation methods:

Uses this transportation method when leaving house...

- | | |
|-------------------|--------------|
| • Drive: | frequently |
| • Bike: | rarely |
| • Walk: | occasionally |
| • Public transit: | rarely |

Vehicle type:	compact
Vehicle fuel type:	gas
Vehicle fuel mileage:	NA

Appliances and electronics in the home:*Has this device or system in their home...*

- | | |
|--------------------------------------|----------------|
| • Security/alarm system: | no |
| • Intercom system (and type): | for front door |
| • CD player: | yes |
| • Television (and number): | 1 |
| • VCR (and type of use): | play / record |
| • DVD player: | yes |
| • Surround sound stereo: | yes |
| • Digital video recorder: | no |
| • Cable TV (and type): | yes |
| • Video game system: | no |
| • Stackable washer/dryer: | no |
| • Washing machine (and type): | no |
| • Clothing dryer (and type): | no |
| • Dishwasher (and type): | built-in |
| • Air conditioning: | no |
| • Full-size refrigerator (and type): | top freezer |
| • Compact refrigerator: | no |
| • Stand-alone freezer: | no |
| • Microwave (and type): | countertop |
| • Portable heater (and number): | no |
| • Hot water heater (and number): | 1 |

Configuration and repair tasks:

Person who sets up VCR / digital video recorder:	self
Use automatic bill pay:	yes
Have automatic timers on lights/appliances:	no
Person who sets up timers on lights/appliances:	NA
Save numbers on cell phone:	yes
Contact when electronics break or you have difficulty using:	read manual / contact customer service / call a relative or friend

Computer ownership and use:

Use computer regularly:	yes
Use for what activity:	personal
Use at home (how many at home):	1
Use at work:	yes
Where internet used:	home
Internet connection at home:	56k modem
Wireless network at home:	don't know

Use of services and devices:

Frequency of use for the following...

- | | |
|------------------------------------|----------------|
| • Email: | frequently |
| • Internet: | occasionally |
| • Voice mail: | rarely |
| • Online banking: | never |
| • Electronic calendar or schedule: | never |
| • Self-checkout at store: | frequently |
| • Purchasing from websites: | never |
| • Text messaging: | never |
| • Computer or laptop: | frequently |
| • Answering machine: | frequently |
| • Cell phone: | occasionally |
| • PDA: | don't have one |
| • MP3 player: | don't have one |

Information about energy use:

- | | |
|---|-----------|
| Knows age of refrigerator at home (how old): | 0-2 years |
| Can guess monthly energy bill for a given season: | yes |

Would like to know about...

- | | |
|---|----------|
| • Where energy is used in household: | not sure |
| • Appliances to replace for energy savings: | agree |
| • Light bulbs to replace for energy savings: | agree |
| • Appliance maintenance for energy savings: | agree |
| • Personal behavior change for energy savings: | agree |
| • Residents' behavior change for energy savings: | not sure |
| • Comparison of energy use to other local households: | agree |
| • Comparison of energy use to national households: | agree |
| • Household energy use affect on environment: | agree |

- | | |
|--|---|
| Want to know about energy usage for an appliance: | yes |
| What appliances/energy information: | "TV, VCR, Treadmill, computer, microwave, refrigerator, showers, dishwasher." |
| Any other info about public utility energy usage: | "why does it cost what it costs and what are all the fees!?" |
| Top motivation to save energy from public utilities: | save money |
| Best way to save energy from public utilities: | "keep appliances low / off when not in use for a reasonable period of time." |

Personal information:

Participant ID:	A5
Gender:	Female
Age range:	56-60
Occupation:	retired professor / medical specialist
Employment status:	retired
Marital status:	divorced

Household residents:

Owns a pet:	yes
Type and number of pets:	1 cat
Number of children:	2
Ages of children:	31, 32
Number of children living with you:	none
Number of household residents:	1

Home and homeownership:

City of residence:	Victoria, BC
Homeowner:	yes
Homeowner for how long:	16+ years
Type of home:	single-family home
Length of residence at this home:	1.5 years
Number of bedrooms:	4
Number of bathrooms:	2.5
Number of floors:	2+basement
Size in square feet:	2500
Regularly water lawn:	no
Lawn irrigation method:	NA
Winter heating method:	gas / oil
Summer cooling method:	open windows / keep sun out

Division of household responsibilities:

This person is responsible for...

- | | |
|--|------|
| • Decisions about appliance replacement: | self |
| • Meal preparation: | self |
| • Laundry: | self |
| • Housecleaning: | self |
| • Yard work: | self |
| • Bill payment: | self |

Use of transportation methods:

Uses this transportation method when leaving house...

- | | |
|-------------------|------------|
| • Drive: | frequently |
| • Bike: | NA |
| • Walk: | frequently |
| • Public transit: | NA |

Vehicle type:	sedan
Vehicle fuel type:	gas / oil
Vehicle fuel mileage:	26-36

Appliances and electronics in the home:*Has this device or system in their home...*

- | | |
|--------------------------------------|---------------|
| • Security/alarm system: | no |
| • Intercom system (and type): | no |
| • CD player: | yes |
| • Television (and number): | 1 |
| • VCR (and type of use): | play |
| • DVD player: | no |
| • Surround sound stereo: | no |
| • Digital video recorder: | no |
| • Cable TV (and type): | digital |
| • Video game system: | no |
| • Stackable washer/dryer: | no |
| • Washing machine (and type): | front loading |
| • Clothing dryer (and type): | front loading |
| • Dishwasher (and type): | built-in |
| • Air conditioning: | no |
| • Full-size refrigerator (and type): | side-by-side |
| • Compact refrigerator: | no |
| • Stand-alone freezer: | no |
| • Microwave (and type): | countertop |
| • Portable heater (and number): | no |
| • Hot water heater (and number): | 1 |

Configuration and repair tasks:

Person who sets up VCR / digital video recorder:	NA
Use automatic bill pay:	yes
Have automatic timers on lights/appliances:	yes
Person who sets up timers on lights/appliances:	self
Save numbers on cell phone:	no
Contact when electronics break or you have difficulty using:	read manual / customer service / hire a pro / ask children / other:"yell and curse!"

Computer ownership and use:

Use computer regularly:	yes
Use for what activity:	personal
Use at home (how many at home):	1
Use at work:	NA
Where internet used:	home
Internet connection at home:	DSL
Wireless network at home:	no

Use of services and devices:

Frequency of use for the following...

- Email: frequently
- Internet: frequently
- Voice mail: frequently
- Online banking: rarely
- Electronic calendar or schedule: never
- Self-checkout at store: never
- Purchasing from websites: never
- Text messaging: never
- Computer or laptop: frequently
- Answering machine: never
- Cell phone: occasionally
- PDA: don't have one
- MP3 player: don't have one

Information about energy use:

- Knows age of refrigerator at home (how old): 0-2 years
- Can guess monthly energy bill for a given season: yes

Would like to know about...

- Where energy is used in household: agree
- Appliances to replace for energy savings: disagree "all are new except furnace"
- Light bulbs to replace for energy savings: agree
- Appliance maintenance for energy savings: agree
- Personal behavior change for energy savings: agree
- Residents' behavior change for energy savings: disagree
- Comparison of energy use to other local households: agree
- Comparison of energy use to national households: agree
- Household energy use affect on environment: agree

- Want to know about energy usage for an appliance: yes
- What appliances/energy information: "ventilation and heated air return system for gas cooktop :: -how much electricity?"
- Any other info about public utility energy usage: NA
- Top motivation to save energy from public utilities: save money / conserve natural resources / reduce pollution / make home more comfortable / other: "my mom said to do it!"
- Best way to save energy from public utilities: "3. water conservation; 2. insulation, double-glazed windows; 1. turn down thermostat"

Personal information:

Participant ID:	A6
Gender:	Female
Age range:	46-50
Occupation:	mother
Employment status:	NA
Marital status:	married

Household residents:

Owns a pet:	yes
Type and number of pets:	2 cats
Number of children:	1
Ages of children:	5
Number of children living with you:	1
Number of household residents:	3

Home and homeownership:

City of residence:	Seattle, WA
Homeowner:	yes
Homeowner for how long:	6-9 years
Type of home:	single-family home
Length of residence at this home:	6-9 years
Number of bedrooms:	2
Number of bathrooms:	1
Number of floors:	2+basement
Size in square feet:	2000
Regularly water lawn:	no
Lawn irrigation method:	NA
Winter heating method:	gas
Summer cooling method:	open windows / portable fan / keep sun out

Division of household responsibilities:

This person is responsible for...

- | | |
|--|---------------|
| • Decisions about appliance replacement: | self / spouse |
| • Meal preparation: | self |
| • Laundry: | self |
| • Housecleaning: | self |
| • Yard work: | self |
| • Bill payment: | self |

Use of transportation methods:

Uses this transportation method when leaving house...

- | | |
|-------------------|------------|
| • Drive: | frequently |
| • Bike: | rarely |
| • Walk: | rarely |
| • Public transit: | rarely |

Vehicle type:	wagon
Vehicle fuel type:	gas
Vehicle fuel mileage:	29

Appliances and electronics in the home:*Has this device or system in their home...*

- | | |
|--------------------------------------|---------------|
| • Security/alarm system: | no |
| • Intercom system (and type): | no |
| • CD player: | yes |
| • Television (and number): | 1 |
| • VCR (and type of use): | play |
| • DVD player: | no |
| • Surround sound stereo: | no |
| • Digital video recorder: | no |
| • Cable TV (and type): | analog |
| • Video game system: | no |
| • Stackable washer/dryer: | no |
| • Washing machine (and type): | top loading |
| • Clothing dryer (and type): | front loading |
| • Dishwasher (and type): | built-in |
| • Air conditioning: | no |
| • Full-size refrigerator (and type): | top freezer |
| • Compact refrigerator: | no |
| • Stand-alone freezer: | no |
| • Microwave (and type): | no |
| • Portable heater (and number): | 1 |
| • Hot water heater (and number): | 1 |

Configuration and repair tasks:

Person who sets up VCR / digital video recorder:	NA
Use automatic bill pay:	NA
Have automatic timers on lights/appliances:	no
Person who sets up timers on lights/appliances:	NA
Save numbers on cell phone:	NA
Contact when electronics break or you have difficulty using:	read manual / search online / customer service / ask spouse / call a relative or friend / purchase replacement

Computer ownership and use:

Use computer regularly:	yes
Use for what activity:	personal
Use at home (how many at home):	1
Use at work:	NA
Where internet used:	home
Internet connection at home:	56K modem
Wireless network at home:	no

Use of services and devices:

Frequency of use for the following...

- | | |
|------------------------------------|----------------|
| • Email: | occasionally |
| • Internet: | frequently |
| • Voice mail: | frequently |
| • Online banking: | never |
| • Electronic calendar or schedule: | rarely |
| • Self-checkout at store: | occasionally |
| • Purchasing from websites: | rarely |
| • Text messaging: | never |
| • Computer or laptop: | frequently |
| • Answering machine: | frequently |
| • Cell phone: | don't have one |
| • PDA: | rarely |
| • MP3 player: | never |

Information about energy use:

Knows age of refrigerator at home (how old):	not certain
Can guess monthly energy bill for a given season:	no

Would like to know about...

- | | |
|---|----------------|
| • Where energy is used in household: | agree |
| • Appliances to replace for energy savings: | agree |
| • Light bulbs to replace for energy savings: | agree |
| • Appliance maintenance for energy savings: | strongly agree |
| • Personal behavior change for energy savings: | strongly agree |
| • Residents' behavior change for energy savings: | agree |
| • Comparison of energy use to other local households: | not sure |
| • Comparison of energy use to national households: | NA |
| • Household energy use affect on environment: | strongly agree |

Want to know about energy usage for an appliance:	yes
What appliances/energy information:	"clothes dryer - how much contributes to utility bill"
Any other info about public utility energy usage:	"can't think of anything."
Top motivation to save energy from public utilities:	save money
Best way to save energy from public utilities:	"keep lights off when not using them."

Personal information:

Participant ID:	A7
Gender:	Female
Age range:	41-45
Occupation:	student, studying to be an architect
Employment status:	student, studying to be an architect
Marital status:	married

Household residents:

Owns a pet:	yes
Type and number of pets:	1 cat
Number of children:	2
Ages of children:	10, 7
Number of children living with you:	2
Number of household residents:	4

Home and homeownership:

City of residence:	Newcastle, WA
Homeowner:	yes
Homeowner for how long:	10-15 years
Type of home:	single-family home
Length of residence at this home:	10-15 years
Number of bedrooms:	4
Number of bathrooms:	2.5
Number of floors:	2
Size in square feet:	2700
Regularly water lawn:	yes
Lawn irrigation method:	hose with sprinkler
Winter heating method:	gas
Summer cooling method:	open windows / portable fan / keep sun out

Division of household responsibilities:

This person is responsible for...

- | | |
|--|--------------------------------|
| • Decisions about appliance replacement: | self / spouse |
| • Meal preparation: | self / spouse |
| • Laundry: | self |
| • Housecleaning: | self / children / someone else |
| • Yard work: | self / spouse |
| • Bill payment: | self / spouse |

Use of transportation methods:

Uses this transportation method when leaving house...

- | | |
|-------------------|--------------|
| • Drive: | frequently |
| • Bike: | never |
| • Walk: | occasionally |
| • Public transit: | frequently |

Vehicle type:	wagon
Vehicle fuel type:	gas
Vehicle fuel mileage:	NA

Appliances and electronics in the home:*Has this device or system in their home...*

• Security/alarm system:	yes
• Intercom system (and type):	no
• CD player:	yes
• Television (and number):	1
• VCR (and type of use):	record
• DVD player:	no
• Surround sound stereo:	no
• Digital video recorder:	no
• Cable TV (and type):	analog
• Video game system:	no
• Stackable washer/dryer:	no
• Washing machine (and type):	top loading
• Clothing dryer (and type):	front loading
• Dishwasher (and type):	built-in
• Air conditioning:	no
• Full-size refrigerator (and type):	side-by-side
• Compact refrigerator:	no
• Stand-alone freezer:	no
• Microwave (and type):	built-in
• Portable heater (and number):	no
• Hot water heater (and number):	1

Configuration and repair tasks:

Person who sets up VCR / digital video recorder:	self
Use automatic bill pay:	no
Have automatic timers on lights/appliances:	yes
Person who sets up timers on lights/appliances:	self
Save numbers on cell phone:	no
Contact when electronics break or you have difficulty using:	read manual / search online / hire a pro / ask spouse / purchase replacement

Computer ownership and use:

Use computer regularly:	yes
Use for what activity:	personal / work
Use at home (how many at home):	4
Use at work:	yes
Where internet used:	home
Internet connection at home:	DSL
Wireless network at home:	no

Use of services and devices:

Frequency of use for the following...

- | | |
|------------------------------------|----------------|
| • Email: | frequently |
| • Internet: | frequently |
| • Voice mail: | never |
| • Online banking: | frequently |
| • Electronic calendar or schedule: | never |
| • Self-checkout at store: | occasionally |
| • Purchasing from websites: | frequently |
| • Text messaging: | never |
| • Computer or laptop: | frequently |
| • Answering machine: | frequently |
| • Cell phone: | occasionally |
| • PDA: | don't have one |
| • MP3 player: | don't have one |

Information about energy use:

Knows age of refrigerator at home (how old):	11-15 years
Can guess monthly energy bill for a given season:	no

Would like to know about...

- | | |
|---|----------|
| • Where energy is used in household: | not sure |
| • Appliances to replace for energy savings: | disagree |
| • Light bulbs to replace for energy savings: | not sure |
| • Appliance maintenance for energy savings: | not sure |
| • Personal behavior change for energy savings: | not sure |
| • Residents' behavior change for energy savings: | not sure |
| • Comparison of energy use to other local households: | not sure |
| • Comparison of energy use to national households: | not sure |
| • Household energy use affect on environment: | agree |

Want to know about energy usage for an appliance:	no
What appliances/energy information:	
Any other info about public utility energy usage:	NA

Top motivation to save energy from public utilities:	conserve natural resouces
Best way to save energy from public utilities:	"turn off things that don't need to be on."

Personal information:

Participant ID:	A8
Gender:	Female
Age range:	27-30
Occupation:	human resources
Employment status:	full-time employed / student / homemaker
Marital status:	"separated but still unpleasantly living together"

Household residents:

Owns a pet:	no
Type and number of pets:	"the cats died."
Number of children:	1
Ages of children:	3.5
Number of children living with you:	1
Number of household residents:	3

Home and homeownership:

City of residence:	Seattle, WA
Homeowner:	yes
Homeowner for how long:	2-3 years
Type of home:	single-family home
Length of residence at this home:	2-3 years
Number of bedrooms:	2
Number of bathrooms:	1
Number of floors:	1+basement
Size in square feet:	1400
Regularly water lawn:	no
Lawn irrigation method:	NA
Winter heating method:	gas
Summer cooling method:	open windows / portable fan / keep sun out

Division of household responsibilities:

This person is responsible for...

- | | |
|--|---------------------|
| • Decisions about appliance replacement: | self / spouse |
| • Meal preparation: | self / spouse |
| • Laundry: | self / spouse |
| • Housecleaning: | self / someone else |
| • Yard work: | someone else |
| • Bill payment: | self / spouse |

Use of transportation methods:

Uses this transportation method when leaving house...

- | | |
|-------------------|--------------|
| • Drive: | frequently |
| • Bike: | rarely |
| • Walk: | occasionally |
| • Public transit: | occasionally |

Vehicle type:	compact / sedan
Vehicle fuel type:	gas
Vehicle fuel mileage:	28

Appliances and electronics in the home:*Has this device or system in their home...*

- | | |
|--------------------------------------|---------------|
| • Security/alarm system: | yes |
| • Intercom system (and type): | no |
| • CD player: | yes |
| • Television (and number): | yes |
| • VCR (and type of use): | yes |
| • DVD player: | yes |
| • Surround sound stereo: | no |
| • Digital video recorder: | no |
| • Cable TV (and type): | no |
| • Video game system: | no |
| • Stackable washer/dryer: | no |
| • Washing machine (and type): | top loading |
| • Clothing dryer (and type): | front loading |
| • Dishwasher (and type): | yes |
| • Air conditioning: | no |
| • Full-size refrigerator (and type): | top freezer |
| • Compact refrigerator: | no |
| • Stand-alone freezer: | no |
| • Microwave (and type): | countertop |
| • Portable heater (and number): | no |
| • Hot water heater (and number): | 1 |

Configuration and repair tasks:

Person who sets up VCR / digital video recorder:	self
Use automatic bill pay:	no
Have automatic timers on lights/appliances:	no
Person who sets up timers on lights/appliances:	NA
Save numbers on cell phone:	yes
Contact when electronics break or you have difficulty using:	read manual / search online / customer service / ask spouse

Computer ownership and use:

Use computer regularly:	yes
Use for what activity:	personal / work
Use at home (how many at home):	3
Use at work:	yes
Where internet used:	work / home
Internet connection at home:	DSL / dialup
Wireless network at home:	NA

Use of services and devices:

Frequency of use for the following...

- Email: frequently
- Internet: frequently
- Voice mail: frequently
- Online banking: occasionally
- Electronic calendar or schedule: frequently
- Self-checkout at store: rarely
- Purchasing from websites: occasionally
- Text messaging: rarely
- Computer or laptop: frequently
- Answering machine: rarely
- Cell phone: frequently
- PDA: don't have one
- MP3 player: occasionally

Information about energy use:

- Knows age of refrigerator at home (how old): 0-2 years
- Can guess monthly energy bill for a given season: yes

Would like to know about...

- Where energy is used in household: agree
- Appliances to replace for energy savings: agree
- Light bulbs to replace for energy savings: agree
- Appliance maintenance for energy savings: strongly agree
- Personal behavior change for energy savings: agree
- Residents' behavior change for energy savings: agree
- Comparison of energy use to other local households: agree
- Comparison of energy use to national households: agree
- Household energy use affect on environment: agree

- Want to know about energy usage for an appliance: yes
- What appliances/energy information: "-refrigerator / -water heater / -computer"
- Any other info about public utility energy usage: "how the energy is made- hydroelectric? wind? solar? garbage-burning? I want alternatives!"
- Top motivation to save energy from public utilities: reduce dependency / conserve natural resources / reduce pollution / set a good example
- Best way to save energy from public utilities: "conserve, keep things on lowest safe setting, turn off items not in use, eat more raw food."

Appendix K:

Experimental notes

Participant: A1

Pre-tasks

Task 1: “Label the refrigerator”

- A1 examined and applied sensor first, without turning on the handheld for guidance.
- Didn't use the scanning button, swiped the handheld across the barcode.
- “Computer” thought A1 had pushed the button but she hadn't – maintained consistent behavior (no button push required) for rest of session
- Task successful

Task 2: “Label the toaster oven”

- Placed sensor first, then scanned it.
- Didn't use scanning button, swiped across barcode.
- Task successful

Task 3: “Label the living room”

- Scanned sensor first, then placed it.
- A1 had a problem finding the catalog, though had just used it previously.
- Placed sensor on table facing door, did not adhere to wall.
- Task successful

Task 4: Barcode scanning

- Didn't find the emission line at first.
- Upon finding the emission line, scanned items correctly.
- Task successful

Post-task interview

- Scanning was difficult, A1 says a recommendation to aim scanner at hand would help so you can see the line.
- Quick Start Guide – what are the sensors? [Part of the QSG was incomplete...]
- Conceptual model – A1 says system required mapping of sensor to unit
- A1 would be interested in all types of information.
- A1 would like appliances to come with built-in sensors.
- Sensor placement issues – what if glue doesn't come off the wall? what about placement of sensors around toddlers?

Participant: A2

Pre-tasks

- what is text messaging? (cell vs IM)

Task 1: “Label the refrigerator”

- placed on LH side of fridge
- correctly removed sensors from box
- used button to scan barcodes (correct interaction technique), but held close to the barcodes
- Task successful

Task 2: “Label the toaster oven”

- performed correctly and fluently
- Task successful

Task 3: “Label the living room”

- double-glanced at barcodes on room list
- didn’t adhere sensor to the wall – held it up against the wall for a moment, waiting for investigator approval
- Task unsuccessful – didn’t place the sensor reasonably (was on couch at completion)

Task 4: Barcode scanning

- used power button on handheld rather than scan button
- looked for red line emission
- found room barcodes too close together
- awkward to scan at the bottom of page
- awkward angle of attack
- Task successful

Post-task interview

- Conceptual model – switching from appliances to rooms was unclear, correlating sensor to device by scanning barcodes was clear
- A2 suggests providing blank barcodes for labeling other items
- Wonders about how to do an oven/range (has an electric oven/range)
- wants to know how long it would take to pay off appliance upgrade
- wants to know about overhead lights
- wants to know about tivo, computer, modem
- is familiar with barcode scanners – used wedding registry, self checkout, also watched retail clerks
- wouldn’t stick sensors (motion) to wall, even if said to be removable (have plaster walls)
- didn’t know how to position device – what does it sense?
- liked placement of scanning buttons – wouldn’t change to another button
- wants device to have item selection on screen, rather than using catalog

- would like a serial-selection device (like mouse-wheel, etc)

Participant: A3

Pre-tasks

- spent awhile reading paper documentation

Task 1: “Label the refrigerator”

- scanned fridge correctly
- placed handheld over item rather than aiming it at it
- placed sensor on RH side of fridge
- Task successful – scanning directions do not explain *how* to aim scanner

Task 2: “Label the toaster oven”

- completed correctly and fluently
- still placing handheld *over* item
- Task successful

Task 3: “Label the living room”

- imagined more fluency with scanning than exists – gestures generally rather than operates specifically
- adhered sensor to the wall, facing doorway
- Task successful

Task 4: Barcode scanning

- hovered over barcodes similar to WOZ tasks, then found red emission line and aimed at barcodes
- had up-down volume problems with three-way switch
- Task successful

Post-task interview

- ‘menu system’ (his term for UI interface on HH) was pretty informative
- wants a handheld-only interaction mode (ie, without catalog)
- placement seemed ok
- concerned about system cost
- would be interested in the information and willing to take the time to set up
- PRIVACY – where does the information go, and what is collected? wouldn’t want feedback to some organization
- wants to know what sensors sense – proximity vs. location – identity information?
- wouldn’t be willing to stick things on walls
- conceptual model: ‘linking sensor to item it was measuring...’
- conceptual model confusion about appliance needing to know location (system would need to know that refrigerator was in kitchen, when in fact that information would not be gathered or tracked)
- uncertain of where the laser came out
- has used barcode scanners for self-checkout and wedding-registry
- three-way switch was awkward – suggests using middle silver button
- found device a little too heavy

- wanted information – profile of energy usage by day (or hour or month) crossed by appliance
- behavior change information is ok
- wants to know about upgrade information and time-to-payoff
- wants recommendations to take account of additional complexity – running gas line for water heater, for example

Participant: A4

Pre-tasks

- seems reluctant to read QSG thoroughly
- uncertain what sensors are from contents description

Task 1: “Label the refrigerator”

- didn’t know to turn on device right away
- moves back and forth between device and printed materials frequently
- unwilling to trust handheld interface
- confused about which sensor to scan
- confused between V1 and V2 – what did the numbers mean
- scanned wrong method at first but then recovered – aimed, not hovered
- Task successful

Task 2: “Label the toaster oven”

- scanned correctly but with exaggeration
- otherwise fluent and correct
- Task successful

Task 3: “Label the living room”

- scanned room correctly
- place sensor facing away from doorway on floor in front of doorway
- Task unsuccessful – didn’t aim/place sensor appropriately

Task 4: Barcode scanning

- missed first and second scan
- ‘I don’t know if that worked or not’
- ‘don’t beep at me – I don’t know if that’s good or bad.’
- aimed handheld correctly
- ‘oops... basement. I’d delete that one but I don’t know how.’
- ‘oh, I didn’t read the last direction.’
- Task partially successful – learned action, did last two correctly

Post-task interview

- wasn’t sure about which button to use
- ‘button choice depends on the task...’
- has used scanners before at self-checkout
- believed she would have looked at paper items for longer had she been at home without investigators present
- didn’t see anything about which set of directions to follow (quick start guide, handheld, etc)
- wording of the UI loop was awkward
- sensor design was OK
- long names were hard to understand – “top-freezer refrigerator” etc
- pictures are good

- comparison for energy use would be good
- Conceptual model: I don't know what it's doing – wanted more information about sensors
- Conceptual model: “telling the system what it's attached to”
- how do I get back out of any action?
- device is heavy

Participant: A5

Pre-tasks

- year splits on questionnaire were unclear
- which object is the 'item catalog' is not clear

Task 1: "Label the refrigerator"

- put the 'label' (the directive card) on the fridge
- difficulty finding the item catalog
- doesn't scan the catalog item correctly
- wants to know which page of the instruction she is on
- relies on written materials, not HH interface
- wants instructions in one place, not both on HH and on paper
- eventually got lost on this task
- Task unsuccessful

Task 2: "Label the toaster oven"

- used TOC in the item catalog
- swipes items over the HH display rather than scanning them
- "temptation to press help is always strong just to see what they would say"
- Task unsuccessful – scanning is seriously incorrect

Task 3: "Label the living room"

- item catalog binding is difficult to work with – difficult to find beginning end
- became confused by inconsistency between written and displayed instructions
- what is an item?
- wants to go back in the interface
- presses help
- quits
- instructions "should be precise and not skip any steps"
- Task unsuccessful

Task 4: Barcode scanning

- didn't succeed
- "how long do I hold the button down?"
- "am I supposed to see the line?"
- "should I move it left to right?"
- presses the button very hard – turned down device volume by accidentally activating volume switch down
- moved the red line back and forth across barcode (emission line was vertical)
- Task unsuccessful

Post-task interview

- "reminiscent of real experiences with instructions"
- what does scanning mean?

- “how do I hold it?”
- “why don’t I hear a beep?”
- vertical versus horizontal movement
- should I hold it slow or move it?
- didn’t think that pictures would be better unless done very well
- “words are always easier than pictures for me”
- difficulty understanding 3D back-projection
- would have chosen the middle button for scanning function
- aiming scanner: “point it like a laser pointer or flashlight”
- UI design: seemed that next and back had switched positions
- pages should be numbered (paper documentation)
- would help to keep all pages stapled together
- having the QSG diverted from reading proper instructions
- if sensors are sticking magnetically, say so in the instructions
- “label *my* home” in UI
- label -> tag?
- make labeling bold
- information – behavior suggestions would be annoying
- would like competitive baseline information
- would like trend information and long-term information
- conceptual model: was an identification procedure so the computer “knows what it is”

Participant: A6

Pre-tasks

- wants information to bolster arguments about energy usage
- looks through all of item catalog before beginning

Task 1: “Label the refrigerator”

- scans using a sweeping motion, not button
- “Computer” misunderstood scanning requirements, accepted scanning without button for the rest of session
- found IC item easily
- wants to know about using either sensor
- Task successful

Task 2: “Label the toaster oven”

- scans correctly and fluently
- doesn’t ask again about using either sensor
- Task successful

Task 3: “Label the living room”

- scans room correctly
- applies sensor correctly
- adheres sensor to wall
- Task successful

Task 4: Barcode scanning

- looks for line on display rather than as an emission
- discovers and enunciates how to work side button “press in the middle”
- “would have already called the people who sent the box”
- successfully scanned all items on first try
- Task successful

Post-task interview

- wording was vague – was looking for line or in the wrong place
- use “project” rather than “emit”
- “like a flashlight”
- has used self-checkout
- thought scanning was OK, but would have used big button – is lefthanded
- everything in the box was clear
- would be willing to install in own home
- would be interested in all information options
- wants a cost benefit analysis for replacement of appliances
- less interested in competitive information because it wouldn’t offer an incentive to improve if you were already better than the standard/average
- conceptual model: scanning a room didn’t make as much sense
- conceptual model: which sensor used with which appliance

Participant: A7

Pre-tasks

- “I’m a student and would never do this”
- Read QSG thoroughly before beginning

Task 1: “Label the refrigerator”

- turns it on fluently
- moves between directions on screen and on device
- uses the button to scan correctly
- swipes device across barcode scanner
- Task successful

Task 2: “Label the toaster oven”

- fluent and correct
- “This isn’t designed for a left handed person” (referring to black scanning button)
- Task successful

Task 3: “Label the living room”

- “This isn’t as clear to me...”
- adheres sensor to wall
- Task successful

Task 4: Barcode scanning

- scanned correctly the first time
- felt as though she heard a double-beep (not observed)
- Task successful

Post-task interview

- would like to use the big middle button to scan, felt it would be less awkward
- not clear where to put living room sensor
- wanted more information about how sensor was working
- what were the factors in placing the sensor
- generally... “screen told me what to do...”
- wouldn’t install in her own home
- energy usage is not at the top of mind
- not interested in any kinds of information
- behavior change would be annoying
- conceptual model: “which sensor senses what”

Participant: A8

Pre-tasks

- wants to know what the item catalog is for

Task 1: “Label the refrigerator”

- “should I label the appliance and room?”
- “when should I adhere a sensor?”
- “It should say *next*...”
- totally failed to understand scanning actuation model...
- Task unsuccessful

Task 2: “Label the toaster oven”

- fluent
- swipes scanner
- Task successful

Task 3: “Label the living room”

- over where “towards?”
- placed sensor on ledge, not adhered to wall
- gut instinct was to place it in the doorway
- Task successful – placed “correctly,” if not as intended

Task 4: Barcode scanning

- looks for red line, finds it slowly
- presses button for it, but it shuts off before A8 finds the emission
- after initial self-training, is easy
- Task successful

Post-task interview

- “I just want to push next...” (re: scanning error in T1)
- HH scanning takes work
- would have picked big central button for scanner activation
- does not understand having to do appliance and room labeling
- QSG bullets or numbers – do I have to do both?
- Instructions about how it actually works would be useful
- A better understanding of the system would instill confidence
- Information: would be good to know where energy came from
- what about privacy? who gets this information?
- competition would be useful but doesn’t mean it would change behavior
- conceptual model: understood well